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RESEMBLANCES AND DIFFERENCES AMONG AMERICAN UNIVERSITIES.[1]

THE American colleges and universities seem to the public and to their own constituencies to be very different; but as a matter of fact they are much alike, and what is more, they exhibit in a striking degree the same tendencies. In durable institutions tendency is quite as important as actual condition. It is my purpose in this lecture, first, to point out the fundamental similarities among the higher institutions of learning in the United States, and then to indicate briefly the nature and probable outcome of the differences they exhibit. (I ought to premise, however, that my remarks will have no application to the group of American institutions which derive from the Roman Church their form of government, their discipline and their program of studies. This firmly established group of colleges, which are chiefly under the control of the Society of Jesus, breathe the American atmosphere, and are not wholly inaccessible to the spirit of modern science; but being essentially ecclesiastical in structure and methods, they bear little resemblance to the ordinary

[1] An address given by President Eliot, of Harvard University, at Yale University, on November 15. Last year a graduate of Harvard University gave anonymously to Yale University a fund of $10,000, the income of which is to be devoted to the promotion of friendly relations between the two universities. The Yale authorities decided to appropriate the income for a series of lectures from representatives of Harvard University. President Eliot's address was the first of that series.

American college, which is historically Protestant in origin and development, and distinctly secular, though not irreligious.)

I.

The first likeness I wish to point out is the likeness in the constitutions of the bodies which own and govern the American institutions of higher education. At first sight these bodies seem unlike, and there are certainly many diversities among them; but there is a strong tendency toward the same constitution—a tendency which is due to like desires or objects, and to like experiences in the actual working of the bodies originally set up. When the general court of Massachusetts Bay created in 1642, by a natural inventive process, the first governing board for Harvard College, the act prescribed that it should be composed of the governor and deputy governor, the magistrates of the jurisdiction, and the teaching elders of six adjoining towns, with the president of the college. That is, the general court entrusted the infant college to a large group of the leading persons in the little colony. This same sort of thing has since been done all over the country. By skipping 225 years and 1,000 miles westward, I can take an illustration of this truth from the University of Illinois, which was established in 1867. This university was placed under the control of a board of trustees, consisting of the governor, the superintendent of public instruction, the president of the state board of agriculture and twenty-eight citizens appointed by the governor. The twenty-eight citizens appointed by the governor have since been changed to nine elective members; but the idea of the original structure was much the same as that underlying the first Harvard governing board, except that the churches had no representation as such. Going on to the Pacific, we find the University of California governed by a board of regents, seven of whom—including the president of the university—are *ex officio* regents and sixteen are long-term appointed regents, representing the various professions and business occupations, and to some extent the most important California communities. When Cornell University was incorporated in 1865 a very similar collection of men was set up as trustees, eight of them—including the president and librarian of the university—being *ex officio* members of the board, and the other thirty being leading representatives of the various professions and business occupations mostly within the state of New York. The original governing board of Yale University was composed exclusively of Congregational ministers, and remained in that condition for ninety-one years; but in 1772 there were added to this original board the governor, lieutenant-governor and six senior assistants in the council of Connecticut. These six senior assistants were subsequently changed to six senior senators. Thus, more than one hundred years ago the governing board of Yale University was brought into close resemblance to the original Harvard board. These few illustrations really cover all the essential varieties in the single boards of trustees.

Within eight years of the act that established the overseers of Harvard College the general court of Massachusetts established a smaller board under the title of the president and fellows of Harvard College, without repealing the act that had established the overseers of Harvard College. The new board consisted of but seven men, including the president and the treasurer of the university; and to this small board the general power of initiation and all money powers were committed, the overseers becoming a reviewing and examining body whose consent was required to important measures, but which had little power to

originate measures. Thus early Harvard University acquired the double-headed or bicameral organization that has proved invaluable in political constitutions, being in this respect the most fortunate of all the American institutions of learning. The same motives, however, which determined the general court of Massachusetts to charter the president and fellows of Harvard College have prevailed in all subsequent cases, though not expressed as at Harvard through the preferable method of establishing a separate governing board. The large body of trustees of an American college or university can not meet frequently. The members are too numerous, and their residences are so widely scattered that meetings are costly and troublesome. Moreover, they are too large for active executive functions. They have, therefore, as a rule, given large powers to an executive or prudential committee, the members of which can be conveniently brought together, and can give much time and thought to the affairs of the university. In this way many of the advantages of the bicameral organization of Harvard have been secured by the other American institutions. The initiating body is the executive committee, and the trustees inquire, examine and approve or consent.

The composition of the first Harvard governing board—the overseers—has been repeatedly altered by the legislature. The original composition was altered in 1780 to the governor, lieutenant-governor, council and senate of the commonwealth, with the president of Harvard College and the ministers of the Congregational churches of the six towns. Thirty years later the board was reconstituted as follows: The governor, lieutenant-governor, councilors, president of the senate and speaker of the house of representatives and the president of Harvard College, with fifteen ministers of Congregational churches and fifteen laymen elected by the ballots of the majority of the overseers. A few years later the senate of the commonwealth was incorporated in the board of overseers. In 1834 it was enacted that ministers of any denomination might be elected to the board of overseers. In 1851 the senate was dropped and the board was made up of the usual *ex officio* members and thirty persons elected by the senators and representatives of the commonwealth in six equal classes, each class to serve six years. Finally, in 1865, the power to elect these thirty overseers in six classes was conferred on persons who have received from the college the degree of bachelor of arts, or master of arts, or any honorary degree, voting on commencement day in the city of Cambridge. This series of changes in the Harvard board of overseers perfectly illustrates certain common tendencies in American institutions of the higher education which will ultimately bring them all to a great similarity so far as their governing bodies are concerned: in the first place, the amount of political control tends to diminish; secondly, the religious denominations lose influence; and thirdly, the graduates of an institution as such come into possession of some power over it. The state universities have steadily endeavored to diminish the influence of politics in the selection of their boards of trustees or regents; and they have also successfully excluded denominational control —not without effort, to be sure; for strangely enough, there was formerly a considerable amount of denominational control over some state universities, exhibited for the most part in the successive elections of presidents. Finally, many of the older American colleges and universities have succeeded in providing, sometimes by new legislation, and sometimes by tacit understandings, that a portion of the members of the single board of trustees shall be elected by the graduates of the

institution. Thus, ten of the trustees of Cornell University are elected by the alumni, and six of the members of the Yale corporation have been so elected since 1872, these six being graduates of the university. The tendency to exclude political considerations and influences from the government of all colleges and universities is strong, and will undoubtedly become effectual within a moderate number of years, with rare and temporary exceptions. The new Carnegie foundation, which provides pensions for teachers, except in institutions under denominational control, will help to induce institutions of learning to rid themselves completely of that control. It is so natural and proper to give some influence over the fortunes of a college or university to the body of its graduates, so soon as that body becomes large and strong, that the third tendency above mentioned is sure to be more and more exhibited. It can hardly come into full play, however, until the institution has been graduating young men for at least forty years.

II.

Another respect in which the American institutions of learning resemble each other is in the constitution and functions of the body of teachers called the faculty, and in the relations of that body to the governing board and to the students. In almost all cases the faculty has no legal powers, these powers residing in the governing board or boards, but is nevertheless entrusted with very important duties. It ordinarily has the control of terms of admission, of studies, of terms of graduation, and of rules of conduct. The teachers composing this body are paid salaries, which constitute their entire compensation, they deriving no income directly from the students. All American institutions are alike in this respect, and therein they all differ from most European institutions. At Oxford and Cambridge the tutor receives a fee for each student to whom he gives direct personal instruction, and the annual sum total of these fees may be larger than the highest salary of an American professor. At most continental universities a portion of the professor's income comes from the fees paid by the students who take his courses, and this portion of his income may be many fold larger than his fixed salary. There is no corresponding practise in the American institutions. The recent introduction of preceptors at Princeton University, inaccurately described in the newspapers as a copying of the English method, preserves the American custom that the college pays for all the instruction which the student receives —that is, the preceptors are to be paid fixed salaries, and are not to receive fees proportionate to the number of young men who take advantage of their instruction. This is a striking uniformity of practise in American institutions, which has grown up in a perfectly natural way through imitation of the earliest institutions, and because of the conformity of the practise to American needs and preferences.

The subjects of instruction which an American faculty will ordinarily deal with, unless the institution has very scanty means, are singularly uniform. Even a small and poor college will undertake to provide instruction in the classics and at least five modern languages, in mathematics, physics, chemistry, biology and geology, with some of their applications, and in history, political science, economics, sociology and philosophy. This list is much like the list of subjects that were to be taught in the University of Virginia, as declared in the act of the general assembly on January 25, 1819, except that Jefferson's list included the principles of agriculture, anatomy, medicine, the law of nature and nations, and municipal law, and was therefore much in advance of its time. It

should also be said that the University of Virginia contained in its eight independent schools of ancient languages, modern languages, mathematics, etc., the germ of the present organization of a university faculty into separate departments. There is now a large amount of consent as to the main topics a faculty of the liberal arts should teach; and the list is a decidedly comprehensive one. In all American institutions of any size the list includes many more subjects than any one student can pursue during the years of his residence.

The professors in an American institution are, as a rule, independent in their work, and themselves conduct the examinations in their several courses. They are not subject to outside bodies of examiners. Their instruction is not limited by the scope of an examination paper which another authority sets; and even the control of the faculty as a body over the work of an individual professor is so tenderly used as to be but rarely felt as a check on the individual teacher's will. The general assumption about the tenure of a professor is that his office is for life. Occasionally, in very new institutions, or in institutions over which political spoilsmen have won some control, exceptions to this rule come to the knowledge of the public; but the dismissal of professors is generally regarded by the public as evidence of an institution's inexperience, or of some temporary intrusion of forces or heats alien to the common university spirit.

The conduct of governing boards towards members of a faculty is generally marked by a high degree of respect and consideration; and great weight is attached to the faculty's advice on all matters lying within their recognized province. This is one of the reasons for the preference all American scholars exhibit for the service of colleges and universities rather than of public schools. Another reason for this preference is the departmental organization of instruction in all American colleges and universities. This organization began at Harvard College in 1766, and was then an invention of great novelty and interest. Previous to that time one tutor had given instruction in all subjects to the whole of a college class during the four years of its residence, a few lectures by the two or three professors being added to this large body of instruction given by one man. The departmental method in one hundred and forty years has spread all over the country, and has become universal in the institutions of higher education. It has also pretty well penetrated the secondary schools, and is on its way into the lower grades. Even during the last fifteen years the departments of instruction in the large universities, like Yale, Columbia and Cornell among the endowed institutions, and Michigan, Wisconsin and California among the state universities, have gained much in influence and power, because they have been organized better and better, and their membership has become more numerous and more united in the pursuit of common ends. At Harvard University the development of the department in merit and power as a working body has been one of the most striking internal improvements of the last ten years. A peculiarity of this development at Harvard has been that the chairman of a department is ordinarily changed every few years, and that in the choice seniority is not much regarded. Even an assistant professor may be chairman.

III.

An American faculty almost always feels a strong sense of responsibility for the conduct of their students, and give much thought to the effects of their teachings and rules and of the common academic life on the character of the student. Not every professor feels this responsibility; but

nevertheless a sense of duty towards the students in respect to the formation of character may be said to be characteristic of all the American faculties; and in this respect they all differ widely from similar bodies in Europe. The German professor, or the French professor, desires to impart to his students instruction and inspiration. He wishes to command their respect, rouse their ambition, and open their minds; but he seldom feels much responsibility for the conduct of university students. The old English universities inherited some monastic habits and a purpose to control the conduct of their students by physical means, such as requiring their habitual presence in chapel and dining hall at fixed hours, and the regular occupation of their chambers at night behind bars and gates; and to this day college buildings at Oxford and Cambridge are constructed with reference to these survivals of an antiquated discipline. The American college professor or instructor, in whatever part of the country he works, feels his responsibilities, but of course has none of the archaic English means and methods of exercising a physical control over his students. He trusts to example, to good traditions, and to that exhortation or guidance which rules supply, even when it is notorious that they can not be uniformly enforced. The faculty is generally reenforced in the exercise of their moral control by the public opinion of the alumni and by the *esprit de corps* of the students; but these supports are rather influences than forces. Hence the great importance in all the institutions of higher education, where large numbers of students congregate, of the transmissible spirit of the place, or the body of traditions handed down year by year from the older to the younger students. This spirit of the place is a compound of transmitted sentiments, manners and customs. There are numerous varieties of it; and yet the resemblances between the spirits, tempers or atmospheres of different institutions greatly exceed the differences. The sentiments nourished at all the American seats of learning are partially indicated by the few words which find place as mottoes on their seals, such as truth, light, learning, knowledge and training, labor, the people's safety and freedom through the truth. Baccalaureate and commencement addresses of exhortation, congratulation and hope are astonishingly alike at all the colleges and universities, for the reason that the institutions cherish the same aspirations and ideals. They are all ardent believers in the possibility of increasing human efficiency and happiness. When they study evils and abuses, it is in hope of discovering remedies or preventives. When they give much attention, as most of them have lately done, to studies in history, economics and government, they are looking for guidance to feasible reform and sound progress. The same altruistic spirit actuates them all.

The sense of responsibility for the conduct of the students and for the reputation of the university leads naturally to the devotion of an appreciable proportion of an American professor's time to matters of administration. The growing authority of the department as an organization has a similar tendency. The group of teachers that constitute a department are naturally ambitious to promote the study of their subject, to increase the amount of instruction offered by it, to improve the quality of that instruction, and to win for their department the increasing respect of the faculty and the students. They are always conferring with each other and with the older students for the promotion of these ends; and an appreciable proportion of their working time is spent in these administrative ways. The general welfare of the institution and its position among the neighboring or kindred institutions are sub-

jects of discussion in the faculty and its numerous committees; and these discussions take time and tax vitality. On many professors who are by nature attractive and sympathetic the students make exhausting demands for counsel and encouragement. The prosperous and progressive American institutions are all alike in expecting services of this nature from professors and other teachers, both old and young; so that the despatch of some administrative duties is a common part of the function of an American professor.

Another call often made on the American teacher is to create or care for collections, and to conduct the business of laboratories. These business-like functions are not unwelcome to professors who are fit for them. Indeed, some professors like these functions better than any others, and make themselves more useful in these directions than they could in any other; but, welcome or unwelcome, they fall to the lot of a large proportion of the higher teachers of a university, and take their time away not only from teaching but from research. To the creation and care of collections some of the most eminent American scientists gave a large proportion of their time, as, for example, Asa Gray, the botanist, and Louis Agassiz, the zoologist, at Harvard; James T. Dana, the geologist, and O. C. Marsh, the paleontologist, at Yale; James Hall, the geologist, at Albany; and Joseph Henry, the physicist, who was for thirty-two years secretary of the Smithsonian Institution at Washington. Innumerable lesser men have devoted to administrative work, or to libraries, collections and laboratories very significant portions of their total working time.

The governing bodies of American universities being generally composed of men not themselves experts in any of the university activities, the real direction of those activities devolves on the professors and other teachers; and there is no avoiding this delegation of power. For an American professor, or an American faculty as a whole, such questions as these are always open—how much administrative work shall fall to a professor? to what extent may administrative work, including museum work, be safely entrusted to special officials who are not teachers, but devote themselves almost exclusively to administration? and to what extent should scientific investigation and literary productiveness be made the function of men separated from the large class of university teachers, and expected to devote themselves to original research? Thus far, the expectation of all the American colleges and universities has been to combine these three functions—teaching, administration and research—or at least two of them, in the single person of the professor; and to-day this remains the commonest expectation, especially in the sciences, both pure and applied. Of late years the demand for men as professors who are capable of original research has been rising; that is, in selecting professors more account has lately been taken of proved capacity in this direction than used to be; but still there are very few positions in the United States where the prosecution of scientific investigation is made the chief business of a professor. In the thought of American college trustees, research and literary production are not separate functions, but accompaniments of teaching, to be maintained all the time, like bodily exercise, in connection with other stated occupations. The Germans have done more than any other people to create positions for investigators; and they have invented and put into force certain regulations for such positions which tend to secure the continuous activity of their incumbents. These regulations prescribe a moderate amount of public teaching by lectures or periodical reports, and the instruction and training of

some small number of assistants and advanced students who are frequently replaced. They really effect a combination of investigation with teaching, under the expectation that the greater part of the vital force of the professor will go to investigation. The triple function of the American professor and the American faculty illustrates perfectly the community of ideals in the institutions of higher education. American colleges and universities are unanimously of James Mill's opinion that to propagate the truth and to serve mankind are the only worthy objects of ambition, but with them to propagate means to seek, discover and bring forth truth, as well as to diffuse it. To accomplish these—the only worthy objects—requires direct teaching, conscientious administration, and eager research—all three.

IV.

All the American colleges have now adopted the elective system of studies, though not all to the same degree or extent. In general, a college or university teaches as many of the subjects for which there is a visible demand as the pecuniary resources of the institution permit; or, in other words, it maintains as broad an elective system as the number of teachers it is prepared to pay for can provide. There is, however, one other important limitation of the application of the elective system in the American colleges. Most of them receive their pupils from the secondary schools in such a condition that they feel obliged to devote one year, or even more, to studies appropriate to the secondary schools but not pursued there. They combine with these belated subjects a few of the most elementary subjects appropriate to colleges, and thus make up a prescribed freshman year, or, in some instances, a prescribed course for the freshman and sophomore years. This policy is, of course, a temporary one. It has already disappeared in some of the strongest institutions; and its complete disappearance in the American colleges and universities is only a question of time, for its evils are considerable. It reduces undesirably the number of years which the student can devote to the subject or subjects of his choice. It will make, for example, a great difference in the attainments of a young student of economics, or government, or physics, whether he can take a succession of courses, one or two at a time, in his chosen subject during four years, or three years, or only two years. The third or the fourth year given to advanced courses in his chosen subject is vastly more profitable than either of the underlying years. The ambition of departments, and their steady pursuit of their departmental interests, are sure to contribute powerfully to the remedy of this defect in the application of the elective system. Every department is always trying not only to increase the number of courses it offers, but also to prolong the series of courses which it offers in succession to persevering students. This departmental action tends to extend the instruction offered by the university, and to broaden and enrich the intellectual life of the institution. The advanced students who are attracted to a department which offers a long series of consecutive courses will contribute largely to make the university a place of research as well as of instruction. It is needless to remark that this expansion of advanced teaching is costly; it is worth all its costs.

Few people seem to understand how long and slow has been the growth of what is now called 'the elective system' in the American colleges and universities. It is eighty-one years since the University of Virginia was opened, with no general curriculum, the students selecting their classes or schools for each year. It is eighty years

since the beginnings of what is now the elective system appeared in Harvard College. It is more than sixty years since Francis Wayland published his 'Thoughts on the Collegiate System of the United States,' a work which led a few years later to the temporary adoption of a voluntary method at Brown University. For the first forty years of this long period the progress in liberty of choice for the student was slow; but for the last forty years it has been rapid, partly because of the great number of new subjects which have forced themselves on the attention of the educated public and the business world, and partly because the resources of the institutions of higher education in the United States have increased during the last half of this period very much more rapidly than they did during the first half.

In the long discussion of the effects of the elective system disproportionate attention has been given to the effect on the student of the liberty to select his studies from a large number of various courses. The most far-reaching effects of the elective system are its effects on the profession of teaching as a whole, and on national scholarship. Through the working of the system, the range of studies in the American universities, not for undergraduates only, but for graduates and professors, has been greatly widened. The standards of attainment for both teachers and taught have been much raised; intellectual efficiency has increased and the expectations and duties of the universities with regard to their own productiveness and influence have been exalted. The academic world of to-day hardly remembers the intellectual poverty of the American college of fifty years ago, when the entire amount of instruction offered by most colleges was the amount which a single student could absorb in four years—most of it being, of course, strictly elementary in quality, as well as thus closely limited in quantity. The titles of some of the older professorships in Harvard College indicate the expectation that one professor could occupy satisfactorily several large fields; thus, the professor on the Alford foundation, which dates from 1789, was expected to cover natural religion, moral philosophy and civil polity, and down to 1871 that small part of his time which this one professor could give to civil polity provided all the instruction there was in Harvard University in the subject of economics. The Hollis professorship of mathematics and natural philosophy was founded in 1727; and no other professorship of mathematics existed in the university for one hundred years, the one Hollis professor having charge of mathematics and of the entire subject which now goes under the general name of physics. There are still in the United States some colleges where the professors occupy not chairs but settees, as Dr. Oliver Wendell Holmes said of himself when he taught anatomy, physiology and microscopy; but these settees are fast falling to pieces. The change from a uniform prescribed curriculum, through which the college undertook to carry on to graduation almost all the young men who entered together in any given year, to a range of studies so wide that no two students need pursue precisely the same course between entrance and graduation has been very wholesome all over the country in another respect—it has made the college less an administrative machine for turning out an average routine product, and more a living fountain of individual scholarly interest and ambition.

V.

The large and strong universities in America are alike in their general purpose to provide good training for all the professions or intellectual occupations. It was two endowed institutions—Harvard and

Yale—that started scientific schools almost simultaneously in 1846–7; and this purpose characterizes the great endowed institutions to-day quite as strongly as it does the state universities. To this general proposition there is only one important exception; the state universities and many of the endowed institutions give no direct training for the ministry. For law, medicine, teaching, engineering of all sorts, mining, agriculture, manufacturing, the mechanic arts, and business, the American universities, so far as they discern the needs of the country, make the amplest provision which their resources permit. Several of them have lately added architecture to the list of their professional subjects. The training of professional musicians in a large sense has been taken up by a few universities. As soon as forestry was recognized as a needed profession in the United States, several universities began to provide instruction in that great subject. It is obviously the purpose of the American institutions of learning to train young men for all intellectual callings, making no distinction among them as regards their dignity and serviceableness.

The one exception in the case of the ministry has been made by the state authorities, because the states can not well admit single denominations to the control of theological instruction in their universities, and until recently undenominational theological instruction has not been recognized as a possibility. Many of the endowed institutions have so dreaded denominational control that they have preferred to omit altogether the department of divinity from their organization. Even institutions expressly created to spread a knowledge of the gospel and to prepare missionaries and schoolmasters, like Dartmouth College, for example, have omitted to establish a school or department of theology, preferring to send their graduates in search of theological training to special schools, or to other colleges which maintain a department of divinity. In this respect the case of Dartmouth College is particularly interesting, for it maintains a medical school, a school of science and the arts, a school of civil engineering and a school of administration and finance, but no school of theology.

The University of California very well illustrates the comprehensive purpose of American universities with regard to professional training. In addition to colleges of letters, of social science and of natural science, it maintains colleges of commerce, agriculture, mechanics, mining, civil engineering and chemistry, an institute of art, a college of law, a medical department, a dental department and a college of pharmacy. This purely state university is well matched by Cornell University on the other side of the country, a university governed by a board of trustees, and enriched by many private benefactions, but also by the bounty of the United States and the state of New York. This institution comprehends, in addition to the college of arts and sciences, a graduate department, the college of law, the medical college, the New York state veterinary college, the college of agriculture, the college of architecture, the college of civil engineering and the college of mechanical engineering and mechanic arts. It is clear, therefore, that the American universities intend not only to train men for the professions long called learned, but to 'promote the liberal and practical education of the industrial classes in the several pursuits and professions in life,' to quote the act of Congress approved July 2, 1862, granting to the several states public lands for educational purposes. Of course, many American colleges and universities are at present unable to furnish this great variety of professional instruction; but they all wish to do so, and all press that way as fast

as possible. It is also true that separate schools have been set up in many parts of the country to train young men for the technical and scientific professions; but in time these schools are likely to be transferred to neighboring universities, or to content themselves with training men for the lower grades of these professions, the universities all over the country being sure to appropriate the training of young men for the higher walks of the scientific professions and of business. The same forces which have carried the separate law schools and medical schools into the universities will carry the technical schools in the same direction, unless indeed these schools accept a lower function, like the training of foremen, draughtsmen, surveyors, assayers and the like. In respect to this comprehensiveness the American universities differ widely from the English Oxford and Cambridge, in which training for the professions has always had but a small place, unless indeed such preparation as these universities have long given for admission to orders in the Anglican church can by courtesy be called professional training. It is obvious that the policy of the American universities now under consideration has had, and is going to have, a strong effect to uplift the relatively new professions, like those of engineering, applied chemistry, architecture, music, mining, forestry, the public service, transportation and large scale manufacturing. These are highly intellectual occupations not yet universally recognized as on a level with divinity, law and medicine. The American universities will, in a few generations, put them all in their higher grades absolutely on a level with the older callings.

VI.

The American colleges and universities are alike again in their confident expectation of gratitude and support from their graduates; and the American public cordially sympathizes in this expectation on the part of the institutions and in the grateful and affectionate feelings of the graduates. For example, the public expects its own servants to exhibit a frank affection for the places of their education, and to show partiality for the graduates of their own particular institutions. It rather likes this partiality, as the natural result of youthful friendship and association. Every American institution of higher education counts on services to be rendered to it by its graduates, when they have come to places of influence and power, and esteems the success of its graduates in after life its own best asset, and its surest ground for public confidence and support. The endowed institutions rely on pecuniary support from most of their graduates who prosper in business or in the professions; and this reliance seems to be sound, in proportion to the age and merit of the respective institutions. The older they grow, and the greater their success in teaching and in scientific and literary production, the surer is their reliance on the disposition of the alumni to contribute substantially to the enlargement and improvement of their resources. This is one of the reasons that the American colleges and universities are so eager to train young men for the highest efficiency in all the professions and other intellectual occupations. Efficiency leads to success in all walks of life; and the success of its graduates is sure to contribute to the prestige and prosperity of any institution of the higher education, and to improve its material resources.

It is now time to consider briefly some of the differences among the American colleges and universities. It is certain that they have many strong and deep resemblances. What are their differences; and are they as well marked as the resemblances? The resemblances spring from a

similar historical development of policies and ideals; the differences are largely external, though not without importance. Thus, the sites of the American colleges and universities vary greatly in their natural beauty and their artificial surroundings. Some, like Columbia, Pennsylvania, Tulane and Chicago, have thoroughly urban sites, and those unlovely surroundings which are inevitable in the midst of a dense population. Others have suburban sites, capable of presenting some pleasant aspects of trees, shrubs and flowers, and lying within easy reach of the real country, or of public parks and forests. Others again are situated in small towns or villages where they possess considerable estates of their own, and are surrounded by the open country. These small college or university towns sometimes possess great natural beauties, such as hills, lakes or wooded glens near by, or mountains in the distance can give; while others have been placed on sites singularly devoid of natural beauty, or of interesting objects in their landscape. These differences of situation undoubtedly affect considerably the sentiments of the students towards their respective colleges, and in some degree the turn of their minds towards natural beauty. One can not but believe that such a prospect as that which the University of Virginia commands towards the Blue Ridge, or the University of California through the Golden Gate, must have a life-long effect on the mental habits and outlook of the young men and women who learn to love it. The ideal university ought to have a seat as beautiful as that of the Academy of Athens.

The American colleges and universities are situated in very different climates as regards summer heat, winter cold, dryness or dampness and exposure to malarial influences; and those most favorably situated for the promotion of health and hard work at all seasons of the year will doubtless prove to possess some permanent advantages over those whose situations are less desirable in this respect; but after all the main differences among these institutions as regards situation will in the long run be found to consist in their relative detachment or isolation from large concentrations of population. There will probably always be families or parents who think that young students should be separated from the temptations and distractions of city life, while other equally careful and conscientious people will think that music, the theater, the pleasant activities of polite society and the artistic interests which cities develop are essential accompaniments of the higher education.

The colleges differ widely in the use of dormitories, or halls of chambers, for the students. In an institution like Harvard or Yale, where these halls of chambers are numerous and large, the student life differs somewhat from the student life of a university like Michigan, where there are no such buildings; but the fraternity houses, which have become common in most of the American institutions, diminish considerably this difference in college life which results from the use or non-use of dormitories. The social student life in the different institutions is also affected by the homogeneousness, or heterogeneousness of the students. In most of the eastern institutions the students represent a great variety of family conditions. Some are rich men's sons, and some are poor men's sons; but the majority come from families that are neither rich nor poor. The breadwinners of the families follow an extraordinary variety of occupations. The eastern colleges in general—particularly those that are urban—have therefore had very heterogeneous bodies of students. On the other hand, some of the newer colleges and universities, situated in regions where agri-

culture is the principal occupation of the people, have remarkably homogeneous bodies of students, the fathers of the students being for the most part independent farmers, mechanics, and professional people who themselves live in the country, and are in moderate circumstances. This agreeable homogeneity tends, of course, to diminish, if strong differences of condition are developed among the population on the natural water-shed of the institution, or if the college site, once thoroughly rural, becomes citified through the advent of successful manufactures or of active trade.

There are certain more subtle differences between the American colleges, which it is easy to feel but hard to describe. Some of them have a characteristic tone, or common sentiment, towards some particular religious organization or institution, as for instance, towards the Protestant Episcopal, or the Congregational, or the Presbyterian, or the Methodist church; in some there is such an amount of agreement among teachers, graduates and students on some political dogma, like protection, for example, or bimetallism, or state rights, as to make rejection of that dogma a real difficulty for any discordant individual. Some exhibit a predominant interest in the applications of science; others maintain a strong interest in literature and history—an interest manifested in a striking degree by former generations of teachers and students at the same place, and also by eminent graduates. Others continue to exhibit an affectionate respect for some ethical or religious movement of former times. There is no doubt that the institutions of the north, the south, the east and the west respectively have somewhat different effects on the manners and bearing of their students, just as these students show slight common differences of voice and speech. These local differences are tolerably persistent; although there are now many American colleges to which students come from all parts of the country, bringing with them their own local manners, voices and pronunciations. In spite of these recognizable differences, it is to be observed that the American speech from Canada to the Gulf of Mexico, and from the Atlantic to the Pacific, presents no such strong local variations as little England presents, or as distinguish the north German from the south German.

There seems to be a considerable difference among the American colleges and universities in regard to charging a tuition fee; but this difference is really not so great or so important as it seems. To be sure, some of the state universities charge no tuition fee, while most of the endowed institutions charge a tuition fee varying from $50 to $200 a year; but it is to be observed, on the one hand, that many of the endowed institutions remit tuition fees with liberality, or possess numerous scholarship funds, the income of most of which is sufficient to meet the tuition fee and leave a balance applicable to board or lodging, and, on the other, that the state institutions have established the custom of charging various fees for entrance, incidentals, graduation and laboratory courses. Some of the state universities make a distinction between the college and the school of agriculture and mechanics arts, on the one hand, and the law school and medical school on the other, charging no tuition fee in the first group, but an ample tuition fee in the second. In the state institutions fees for some of the objects just mentioned are invariably collected; and the older the institution the larger these fees are apt to be. Thus, in the University of Michigan the matriculation fee is $10 for a citizen of Michigan and $25 for a person who comes from any other state or country; the fee for incidental expenses in the department of literature, science and the arts is $30 for Michigan students and $40 for all others; and in the

departments of engineering, medicine, law, pharmacy and dentistry this fee is $35 for Michigan students and $45 for all others. Fees are also required from all students who pursue laboratory courses; and in all departments there is a fee of $10 for graduation. The state universities which maintain summer sessions habitually charge a tuition fee for that session. At the University of Michigan this fee is $15 in the department of literature, science and arts. In the University of Illinois fees analogous to those of the University of Michigan are charged; and in addition there is a regular tuition fee of $50 a year in the college of law, and of $120 a year in the college of medicine. The state of California has been liberal to its university and to its schools, and tuition in the colleges at Berkeley is free to residents of the state; but non-residents of California are charged a tuition fee of $20 a year, and there is the usual charge for laboratory supplies, this charge amounting to from $5 to $30 a year. The law school has a fee of $10 a year for incidental expenses, and the medical department has a tuition fee of $150 a year, beside a matriculation fee, a graduation fee, and large fees for dissecting material, the rental of microscopes and laboratory breakage. When we consider, further, that the tuition fee, even where it is large, is seldom more than one third of the total cost of remaining one year in college, and that foregoing the productive labor of the boy is the real difficulty to be met by a poor family in sending a boy to college, we shall perceive that the varying amounts of the annual fees charged for tuition do not present a very serious difference among the American institutions of the higher education. Moreover, the tendency in the state institutions is to enlarge their annual fees under various names; and in the endowed institutions the tendency is to provide more and more scholarships and other aids for poor students, and to offer to competent undergraduates who need to support themselves during their college life better and better opportunities for earning money. Such opportunities are, of course, more easily procured in colleges situated in or near large cities. There they are so abundant that hundreds of young men go through these colleges chiefly on resources which they themselves earn, and graduate without having incurred debt. It is hard to do as much in an institution situated in a village or small town, even though no tuition fee be demanded of the student.

The American colleges and universities differ among themselves considerably in regard to admitting women to common residence and equal standing with men; but here again the differences are not as great as they at first sight appear to be, and they are diminishing. One may say, in a general way, that the leading eastern institutions are not coeducational, and that the leading western institutions are coeducational; but many of the eastern institutions, even those considered most conservative, are partially open to women, and others have entered into more or less intimate association with separate colleges for women placed in the same town or city. Among western endowed institutions there are several that have ceased to be thoroughly coeducational and have decided to segregate the women apart from the men. Leland Stanford Junior University, one of the newest and now one of the richest of American universities, has given notice that it will not, under any circumstances, admit more than a specified number of women. In the eastern part of the country the wholly separate college for women thrives, and gives evidence of present strength and increasing vitality. The probability is that, with the growth of educational resources and the increasing heterogeneousness of the population in the newer parts

of our country, the practises of the west will be assimilated to those of the east in regard to the education of young women with young men—that is, some institutions will remain frankly and throughout coeducational while others will detach the groups of women more or less from the groups of men, and others again will be coeducational in their graduate schools and summer sessions, but not elsewhere. Moreover, both separate colleges for women and colleges for women affiliated with universities for men will probably arise in the west.

A significant distinction among American colleges is based on their terms of admission, some requiring examinations, but the great majority admitting on certificates from secondary schools. Almost all the colleges use each method in some measure; but there is an important group of eastern colleges which admit regular students only on examination. Both methods have been improved and extended in recent years; so that there is now a good chance to test fairly the relative merits of the two methods. That method will ultimately be preferred by schools and colleges alike which delivers to the colleges the ablest, best trained, most ambitious and most efficient boys and girls. Between the two groups of colleges the decisive test will be the success of their graduates in after life. The differentiation among colleges on this basis may turn out to be quicker and more decisive than most experts have imagined, or on the other hand the results may be obscure and hard to demonstrate. Again, a third method, like that of Germany, may supersede both of the existing methods.

Another distinction among the leading universities of this country depends on the proportion which the work they do for undergraduates bears to the work they do for young men who already hold a bachelor's degree. The graduate schools in arts and sciences are increasing rapidly in number and in size; but the number of universities which require a bachelor's degree for admission to their other professional schools is still very small. Here again a sound experiment is in progress under fair conditions, and in ten years more it may be possible for judicious observers to determine what the interest of the universities is in this matter, and what the interest of the community. At any rate, it is certain that preparation for the professions is growing more and more elaborate, and that the influence of the professions steadily increases.

There is an important difference in the organization and management of the American institutions of higher education which has not attracted much public attention, but which really affects strongly the present management of these institutions and their future prospects. In many of the institutions, particularly the older and stronger ones, the president of the college or university is a member of the governing board, or boards, with the full powers of a member. In others, the board of trustees or regents elects its own chairman; and the president of the university, though invited to attend the meetings of the board, is not a member thereof, much less its head. The position of the president who is a member of the governing boards is, of course, stronger than that of a president who is not, provided that his personal quality and his experience are such as to give him influence with the boards. A board of trustees, which invites the presence of the president who is not a member by right, is inclined to look on the president as one of its numerous employees, with whose service they can dispense, if they like, as they would with the services of a professor, instructor or secretary. Such a relation to the governing board impairs the dignity and stability of a presidency, and there-

fore the influence of the incumbent. This is not a local or sectional difference in American universities. Some of the newer endowed institutions in the east have a president who is not a member of the governing board, while some of the state universities of the west have made the president invariably a full member of the board of regents. As the American institutions have grown, the function of the president has become more and more important to their prosperity and progress. In early times the president was the principal teacher. Down to the early part of the nineteenth century he was almost invariably a minister. In most of the larger institutions the president no longer teaches, and in many he is a layman. Common experience during the last fifty years teaches with certainty that the efficiency of any corporation—financial, manufacturing or commercial—depends on its having one responsible head who has knowledge of all its concerns, and gives guidance and inspiration in all its principal activities. A university corporation can not be an exception to this rule for securing efficiency. Again, the experience of the last fifty years teaches clearly that in all fields of human activity it is the trained expert who must invent and give direction. The president of a university must be either an expert himself in educational administration, or he must be a man who thoroughly understands how to utilize expert service. And thirdly, experience proves that long service gives accumulating value to well-selected officials; so that universities which give their presidents an honorable tenure, and get from them long service, will be likely to win great advantages over those who do not.

The American universities are obviously divisible into two groups, the endowed and the state supported, although the endowed may sometimes receive aid from government, and the state supported may possess some endowments. This difference in respect to the sources of their income, however, affects the policies and tendencies of the two groups much less than might be imagined. At present the leading endowed institutions are richer, and have larger annual budgets, than the leading state supported institutions; but, of course, this comparative condition may any year be reversed. It would be hard to prove that any important difference in discipline, educational policy, or scholarly ambition and aim, corresponds with or accompanies this division by sources of income. On the whole, the policies and aims of the two groups are extraordinarily similar. The division is not a strict geographical one. Most of the strong state universities are west of the Alleghenies, but in that vast region strong endowed institutions have also arisen, while in the south both groups exist side by side. California supports the state university of largest annual budget. and is also the seat of one of the richest of American endowed universities. The state universities are all young—Michigan not yet 70 years old, Wisconsin not yet 60, and Illinois, Minnesota and California not yet 40. Their future is very bright; but not brighter than that of the leading endowed institutions. The two sorts of university will both serve the country greatly, maintaining a fine rivalry in scholarship and in serviceableness, making common cause in promoting national intelligence, righteousness and efficiency, and illustrating the best results of the American passion for education. If, then, the American colleges and universities are strikingly similar, in spite of local and unessential differences, it is because they express and illustrate the fundamental convictions, beliefs and aspirations of the American people.

Charles W. Eliot.

SCIENTIFIC BOOKS.

RECENT BOOKS ON THE PHYSICS OF THE ELECTRON.

WHEN it is remembered that the physics of the electron had no recognized existence prior to 1896, that it was 1898 before the corpuscular theory of cathode rays, carrying with it the possibility of the divisibility of the atom, had gained general acceptance, and that it was 1902 before the first book appeared which pretended to treat, in any systematic fashion, the new class of experiments which have to do with atomic ionization, or disintegration, one can not suppress his astonishment at the magnitude of the book literature which exists today upon the general subject of the electron theory. The greater part of this literature is of a popular character, consisting in attempts at the simplification and demathematicization of the technical books and articles which the investigators themselves, for the most part, write. For this reason there is often so great similarity of treatment that neither the busy scientist nor the busy layman can read it all with profit. In fact the bewildering frequency of the appearance of new, popular books in this field leads a reviewer in *Nature* savagely to remark that 'the time is fast coming when the qualification which will play the most important part in determining a man's reputation as a physicist will be that he shall abstain from writing books on the philosophy of ether, matter and the universe.' For my own part, I do not believe that the popular exposition of true scientific knowledge can be overdone. Hence, so long as the authors of new books are true to the scientific spirit, and shun the inviting paths of pseudo-science, I welcome each addition to their ranks. Since, however, the multiplication of books upon the same theme necessitates a choice, the present collective review of the book literature of the electron theory is undertaken with the object of presenting a brief characterization of the most important of these books, with a view of aiding the student of physics, whether he be trained or untrained, in selecting those books which best meet his immediate needs.

It need scarcely be said that the book which is the fountain-head of all electron theory is J. J. Thomson's 'Conduction of Electricity through Gases' (Macmillan, 1893, pp. 1–560). Coming as it does from the pen of the man to whose genius and inspiration more than to that of any other one individual, the physics of the electron owes its origin and its development, the book is as truly epoch-making as any other which has appeared for a hundred years. The student who is thoroughly familiar with its content, and who has also read the same author's somewhat more popular Silliman lectures on 'Electricity and Matter' (Scribners, 1904, pp. 1–162, recently translated into German) is in fairly good touch with the electron theory as it exists to date. It should, however, be said that the discussion of the theory in its relation to metallic conduction finds no place in either of these books and that a few facts have been brought to light since their publication, such, *e. g.*, as Boltwood's proof of the long-suspected relationship between radium and uranium, which have slightly modified certain minor aspects of the theory. The two books together are needed in order to put the reader into intimate contact with J. J. Thomson's views; the former in order to give him, in most convenient form, both a complete review of the experimental data upon which the electron theory rests and the mathematical analysis which it involves; and the latter in order to give him a clear idea, unbefogged by mathematical symbolisms, of the physical pictures, the naked mechanisms, so to speak, which are at the bottom of the author's theoretical investigations. Both books, I take it, are too profound and too technical to be intelligible to the student who has not had thorough training in physics and mathematics; although both, and particularly the latter, may be read with partial understanding, and, therefore, with a certain measure of profit, by workers in other fields of science. These are the two books from which the popular expositors of recent views, from Oliver Lodge down, have drawn the greater part of their material and inspiration.

The only other book the scope of which is as broad as 'The Conduction of Electricity

through Gases' is Johannes Stark's 'Die Elektrizität in Gasen' (Barth, 1902, Leipzig, pp. 1–509)—a book which might have vied in value to the physicist with Thomson's had it not been rendered well-nigh worthless for reference purposes by the slovenly, unscientific and thoroughly un-German way in which references to original articles have been inserted. Like Thomson's book, it covers the whole field of gaseous ionization, whether produced by Becquerel or Roentgen rays, by light, by heat or by electric fields. It exhibits immense reading and profound scholarship. It is, in fact, a magnificent compendium of all the facts of gaseous conduction known at date of writing; but, unfortunately, these facts are so badly mixed up with the author's inferences from them that it is in general quite impossible to tell what is fact and what is inference. It is of the utmost importance that a scientific book, and particularly a book covering a new and speculative field should accompany each statement of fact with a statement of authority as is so admirably done in both Thomson's and Rutherford's recent books. The bewildering mass of references to original articles which Stark gives in connection with each general division of his book is practically worthless, because it is obviously impossible to search through all of them in quest of the verification of some particular statement of fact. In a word, then, a book which, with a little more labor and a little better arrangement, might have been an authoritative reference book for the physicist in a new field, is, instead, an elaborate and, on the whole, decidedly dogmatic presentation of one man's interpretation of recent discoveries—an interpretation which is in many instances questionable, and in some instances certainly erroneous, notably in its relation to induced radio-activity, the stumbling-block of most of the continental physicists. It is, nevertheless, a suggestive and valuable book for the student whose reading and discernment are wide enough to enable him to take at their proper worth its ex-cathedra statements.

Turning now to books of more limited scope, but still books written primarily for the physicist rather than for the general public, Rutherford's inimitable work on 'Radio-activity' (Cambridge University Press, 1904, pp. 1–397, and presently to appear in enlarged and revised form) should unquestionably be given first place. Since it is to Rutherford that the credit for the discovery of the real nature of radioactivity is almost wholly due, the subject having been in a state of hopeless confusion till he brought order out of chaos, his book will probably always stand as the most important contribution which this branch of the physics of the electron will ever receive. Although the author reveals himself in it as the advocate of a theory, he, nevertheless, never jumbles fact and theory as Stark does. In immediate connection with every assertion of fact is found a reference by which the assertion may be checked. From the standpoint of the serious and trained student of radio-activity the book is well-nigh above criticism, for it gives: (1) complete and convenient references to the whole literature of the subject; (2) a clear account of the methods used in the study of the subject; (3) a *résumé* of all the facts discovered to date; (4) a clear discussion of all these facts in the light of the disintegration hypothesis. With suitable revision this book will doubtless long be regarded by the student of radio-activity as his dictionary of the subject. Furthermore, since mathematical processes play a much less prominent rôle than in Thomson's book, and since the style is particularly lucid and interesting, even the general reader will find both interest and profit in its perusal.

A fifth book which every physicist should take an hour or two to read is a small volume of sixty-two pages by H. A. Lorentz, just issued (1905) by Julius Springer in Berlin, and entitled 'Ergebnisse und Probleme der Electronentheorie.' It is a very unpretentious book, being only the publication of a lecture delivered before the Berlin Electrotechnical Society. It contains, however, the first attempt with which I am familiar at a semi-popular treatment of the electron theory in its relation to metallic conductors, a subject

which, on account of its mathematical difficulty no doubt, has thus far received but little attention in the book literature of the electron theory. This pamphlet will be welcomed by all because it gives one of the foremost of the world's investigators upon the mathematical side of the electron theory an opportunity to state the results of his work and to present the present status of the theory from the standpoint of the mathematical physicist.

The last of the books which I shall mention as coming from the hands of the pioneer architects of the structure which we now call the physics of the electron, is the work of the now famous discoverer of radium, Madame Curie. Her thesis, entitled 'Recherches sur les Substances Radioactives' (Gauthier-Villars, Paris, 1904, pp. 1–154), is a plain, conservative record of the history of this discovery and of the most important results obtained by both herself and others in the study of radio-activity. The book, unlike Rutherford's, is uninspired and unillumined by any deep insight into the real nature of the phenomenon under investigation, but it has the inimitable charm of a simple, direct history of one of the world's greatest discoveries told in charmingly modest fashion by the discoverer herself.

To turn now from the books which are primarily for the physicist to the popular expositions of the work of the investigators, there are none of them which do not require for their intelligent reading some elementary knowledge of physics; and if such a book were written it would be too superficial to be in any true sense scientific, for it would have to confine itself to *conclusions* rather than to a presentation of *reasons* for conclusions, and such statements of conclusions are almost invariably misunderstood. Among the books, however, which purport to be written for the general public there are two which show great ability and are characterized by striking individuality. The first place is claimed, in my judgment, by Hon. R. J. Strutt's fascinating, popular treatment of 'Becquerel Rays and the Properties of Radium' (Edwin Arnold, London, 1904, pp. 1–214). This is the book to which I should first refer the non-physicist who wishes to begin the study of the newer investigations which center about the physics of the electron. The author says that his aim has been to give as clear and simple an account of radio-activity as the subject admits of without sacrificing accuracy. He has, therefore, divorced himself entirely from all mathematical modes of statement. He has, nevertheless, succeeded, to a surprising degree, in giving, in simple language, a clear idea of the train of discovery and reasoning which has led to recent conclusions. In the truest sense we popularize science only in so far as we succeed in putting it in such form that the layman can understand, not our conclusion simply, but, in a general way, the reasons for our conclusions also. This Strutt has succeeded in doing. While his treatment is popular, it thoroughly vigorous, scholarly, accurate and conservative, so that it may be unhesitatingly recommended, not only to the general reader who wishes to gain a correct idea of the latest aspect of scientific thought in this domain, but also to the physicist who wishes to gain a clearer vision of the naked physical ideas which are at the bottom of, and sometimes more or less beclouded by, the mathematical presentation of the electron theory.

The other of the two books above referred to is Robert Kennedy Duncan's new work, entitled 'The New Knowledge' (A. S. Barnes and Co., 1905, pp. 1–257). It is a book which will generally be criticized by physicists, I think, as being, to use the author's own adjective, a trifle too 'enthusiastic'—too Jules Vernesque in its implications at least, if not in its statements, to be classed as strictly scientific; and I myself fear that the untrained reader will lay it down with a somewhat erroneous impression of 'the new knowledge'—an impression that a certain quiet evolution which has been going on for the last decade in scientific thought is, instead, a tremendous revolution; that new discoveries have overturned the cornerstones of the old faith. As a matter of fact, in popular presentation, too much emphasis can not be laid upon the fact

that, while our knowledge has been greatly extended in recent years, not a single established doctrine has been upset. The doctrine of the indivisible atom never existed even with Dalton, the father of the atomic theory. A belief in the ultimate possibility of the transmutation of some at least of the elements has been held as firmly by modern scientists, from Faraday down, as by ancient alchemists. Even the doctrine of the conservation of mass in the strictest sense has not been held since Maxwell's time. I am a bit sorry, therefore, that Mr. Duncan does not take more pains to point out that the new discoveries supplement and extend established doctrines instead of setting them aside, and I am particularly sorry that in a book intended for the general reader and purporting to popularize *existing scientific views,* a chapter like that on 'the reconstruction of the universe' should have been introduced. In this chapter, which to my mind, mars a book which is otherwise valuable, despite its enthusiasms, the impression is given that modern discoveries have led us to suspect that *perpetual motion* may still be possible. As a matter of fact, in the light of all recent discoveries, there is not one iota more of probability that the second law of thermodynamics is invalid than there was before any of these discoveries had been made. In spite of these criticisms, and in spite of the fact that throughout the book speculation often wears the air of certitude, I wish to recommend it heartily, not so much to the general reader, for whom it is intended, as to the scientist. Every investigator whose work in a narrow field has limited his outlook will find it immensely suggestive and inspiring. Its author shows himself to be a man of wide reading, thorough scholarship, broad horizon and unmistakable literary talent. I do not find in it one single incorrect statement of fact. The features which differentiate it from books of its kind are: (1) its remarkably fine treatment of the periodic law in its relation to the divisibility of the atom; (2) its popularization of J. J. Thomson's *Philosophical Magazine* article on the constitution of the atom, a difficult but very successful piece of work; (3) its presentation of the bearing of celestial phenomena upon the hypothesis of the evolution of the elements; (4) its statement of Arrhenius's views as to the effect of light, pressure and corpuscular emission upon comets' tails, aurora borealis and other allied phenomena; (5) its capital concluding chapter on the validity of the new knowledge.

The remaining books which deal with the physics of the electron may be briefly mentioned in the order of importance. Frederick Soddy's 'Radio-activity' (The Electrician Printing and Publishing Co., London, 1904, pp. 1–214) is an attractively and ably written book, the outline of which coincides closely with that of Rutherford's, from which it differs chiefly in that it is considerably more elementary and popular. To those who find Rutherford's book a trifle too difficult this will be distinctly helpful.

A. Righi's 'Modern Theory of Physical Phenomena' (translated from the Italian by A. Trowbridge, Macmillan, 1904, pp. 1–165) is a very unpretentious but thoroughly wholesome little book written for the purpose of popularizing for the Italians recent scientific work done mainly by Anglo-Saxons. It devotes a relatively larger space to the discussion of electrolysis and the Zeeman effect than do most of the other popular books of the briefer sort.

Paul Besson's little book, 'Le Radium et la Radioactivité' (Gauthier-Villars, Paris, 1904, pp. 1–166), is written by the man under whose direction the work of extracting radium from pitchblende for the Curies was done. It is the only book upon the subject with which I am familiar which is addressed especially to medical men. The earlier portion follows very closely the outline of Mme. Curie's book, of which it is in fact but an abridgment and simplification, while the last half is devoted to a statement of the uses which radium has found in therapeutics.

Baskerville's 'Radium and Radioactive Substances' (Williams, Brown and Earle, Philadelphia, 1905, pp. 1–161) covers about the field of the last book, but differs from it in presenting more of Rutherford's work and

in bringing the therapeutic applications of radium up to 1905 instead of 1904.

Jacques Danne's 'Das Radium: Seine Darstellung und seine Eigenschaften' (Veit and Co., Leipzig, 1904, pp. 1–84) is a little book which those who wish to familiarize themselves with the chemical side of the extraction of radium from its ores may well consult.

Hans Mayer's 'Die Neueren Strahlungen' (Papanschek, Mähr Ostran, 1904, pp. 1–65) is a rather unsuccessful attempt to present in elementary fashion the theory of cathode, canal, Roentgen and Becquerel rays. It is not characterized by the usual German scholarship, for while it shows wide reading on the part of its author, it contains unpardonable oversights and blunders.

R. A. MILLIKAN.

UNIVERSITY OF CHICAGO,
November 16, 1905.

Principles of Physiological Psychology. By WILHELM WUNDT. Translated from the Fifth German Edition (1902) by EDWARD BRADFORD TITCHENER. Vol. I. London, Sonnenschein; New York, Macmillan. 1904. Pp. xvi + 347.

One can not but admire the industry and courage of Professor Titchener, who, in the midst of an exceptional productiveness of original text-books, ventures also on a translation of so ponderous and difficult a treatise as that of Professor Wundt on physiological psychology. The labor involved and the difficulty of achieving an adequate English version of this important work are, indeed, enormous, as pointed out in a personally interesting preface by the translator. If only the translation is successful in combining the qualities of good English and faithfulness to the original, the undertaking is certainly meritorious and much to be welcomed by readers who are not disposed to cope with the author's German further than is necessary. And, to judge by the present volume, the translation does in fact fulfil these requirements. It is as readable as could be hoped; in fact it is probably easier reading than the original, even though the reader should possess equal facility in both languages. The only reservation to be made on this score is that, as the translator has adopted the Wilder nomenclature for the nervous structures, most readers will need to familiarize themselves with a good number of new technical terms. It impedes the reader's progress to meet 'myel' for the cord, and 'cinerea' for the gray matter. Probably in this matter the translator chose to be a prophet rather than easily read. As to the faithfulness of the translation, here the reviewer's part becomes a serious one. Without pretending, however, to have compared every page of the English with the original, the reviewer can state that he has examined in detail the translation of various difficult passages, and looked up instances where the English suggested a possible error, and after all found only a few little slips. One or two rather obvious errors in the original have passed over into the translation, *e. g.*, at page 286, where, quite in contradiction with the context, the brain-weight of a full-grown orang-utan is given as only 79.7 grams.

A curious error appears in Fig. 79 and in the accompanying text on page 187. It was transferred from the original, and was apparently not passed by the translator without question. The figure purports to show the connection of the retinas with the cerebral hemispheres, but errs in connecting the right half of each retina with the left hemisphere, etc.; the nerve fibers from the nasal half of each retina are stated to pass to the brain without crossing, while those from the temporal halves cross—just the reverse of the truth. As the figure is credited to Vialet, the reviewer looked up Vialet's original figure, and found a rather complicated drawing, which had been simplified by Wundt. In the process of simplification, Vialet's diagrams of the retinas dropped out altogether, and their place was taken by some diagrams of the monocular fields of vision which Vialet had placed in front of each eye to show the crossed relation obtaining between the field of view and the retina, due to the crossing of the rays of light within the eye. Wundt's confusion of the retinas and the fields of vision in the figure led him to reverse the true relations in the text. The error is rather amusing—espe-

cially since another diagram of the same thing (Fig. 99), occurring in a later chapter, is correct—and it is made more so by a 'later note by author,' in which Wundt, whose attention had apparently been called to the discrepancy, while not recognizing the perversion of the figure and text, endeavors to slur over the contradiction in a straddling manner that has a curiously characteristic sound. There are a number of other errors in neurological details, though not by any means a large number. Wundt would of course not be the author to whom one would resort for a knowledge of nervous anatomy and physiology, with which the present instalment of the translation is concerned. The value of this portion of the work lies in the author's broad, if somewhat speculative, views on the general principles of the structure and functions of the nervous system.

The translator has thoughtfully provided a special index for this volume.

R. S. Woodworth.

Columbia University.

SCIENTIFIC JOURNALS AND ARTICLES.

The contents of *The Journal of Comparative Neurology and Psychology* for November is as follows:

Clarence Loeb: 'Some Cellular Changes in the Primary Optic Vesicles of Necturus.'

Raymond Pearl: 'Some Results of a Study of Variation and Correlation of Brain Weight.'

A. H. Roth: 'The Relation Between the Occurrence of White Rami Fibers and the Spinal Accessory Nerve.' (With an Addendum by J. Playfair McMurrich.)

John E. Rouse: 'Respiration and Emotion in Pigeons.'

John B. Watson: 'The effect of the Bearing of Young upon the Body-Weight and the Weight of the Central Nervous System of the Female White Rat.'

The Work of Carl Wernicke.

H. S. Jennings: 'Papers on Reactions to Electricity in Unicellular Organisms.'

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

There will meet at New Orleans:

The American Association for the Advancement of Science.—The week beginning on December 28. Retiring president, Professor W. G. Farlow, Harvard University; president-elect, Professor C. M. Woodward, Washington University, St. Louis, Mo.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor C. A. Waldo, Purdue University, Lafayette, Ind.; secretary of the council, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.

Local Executive Committee.—Honorary president, President E. B. Craighead, Tulane University; executive president, Professor George E. Beyer, Tulane University; secretary, Henry M. Mayo, The New Orleans Progressive League; treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

Section A, Mathematics and Astronomy.—Vice-president, Dr. W. S. Eichelberger, U. S. Naval Observatory, Washington, D. C.; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Henry Crew, Northwestern University, Evanston, Ill.; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Charles F. Mabery, Case School of Applied Science, Cleveland, Ohio; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor F. W. McNair, Houghton, Mich.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Wm. North Rice, Wesleyan University, Middletown, Conn.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor Henry B. Ward, University of Nebraska, Lincoln, Nebr.; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Professor Irving Fisher, Yale University, New Haven, Conn.; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. T. Sedgwick, Massachusetts Institute of Technology, Boston, Mass.; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

At New Orleans in conjunction with the American Association for the Advancement of Science there will meet:

The American Chemical Society.—President, F. P. Venable, University of North Carolina; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Botanical Society of America.—January 4. President, Professor R. A. Harper, University of Wisconsin; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Association of Economic Entomologists.—January 1, 2, 3. President, Professor H. Garman, Lexington, Ky.; secretary, Professor H. E. Summers, Ames, Iowa.

The American Mycological Society.—January 1–4. President, Chas. H. Peck, state botanist, Albany, N. Y.; secretary, C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

At Ann Arbor will meet:

The American Society of Naturalists.—President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University. President (Central Branch), Professor H. H. Donaldson, University of Chicago; secretary, Professor W. J. Moenkhaus, Indiana University. The Eastern Branch will not meet this year.

The American Society of Zoologists (Eastern and Central Branches).—December 28, 29, 30. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor Frank R. Lillie, University of Chicago; secretary, Professor C. E. McClung, University of Kansas.

The Society of American Bacteriologists.—December 28, 29, President, Professor Edwin O. Jordan, University of Chicago; secretary Professor Frederic P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Society for Plant Morphology and Physiology.—December 27, 28, 29. President, Professor E. C. Jeffrey, Harvard University; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

At New York City will meet:

The Astronomical and Astrophysical Society of America.—December 28. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 29, 30. President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

At Cambridge will meet:

The American Psychological Association.—December 27–29. President, Professor Mary Whiton Calkins, Wellesley College; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor John Dewey, Columbia University; secretary, Professor John Grier Hibben, Princeton University.

At Ithaca will meet:

The American Anthropological Association.—December 27–29. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

At Ottawa will meet:

The Geological Society of America.—December 27, 28, 29. President, Professor Raphael Pumpelly; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

THE ASSOCIATION OF TEACHERS OF MATHEMATICS.

THE annual meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held on Saturday, December 2, in affiliation with the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

The following papers were presented:

PROFESSOR H. S. WHITE, Vassar College: 'How should the College Teach Analytic Geometry.'

Mr. H. R. Higly, Pennsylvania College: 'Suggestions for the First Twelve Lessons in Demonstrative Geometry.'

Dr. John S. French, Jacob Tome Institute, Port Deposit: 'Some Essentials of the Successful Mathematics Teacher.'

Dr. H. A. Converse, Baltimore Polytechnic Institute: 'The Teaching of Geometry.'

The association was disappointed at not being able to listen to a paper on 'The Teaching of Pure and Applied Mathematics,' which the program announced was to be read by President R. S. Woodward, of the Carnegie Institution, Washington.

The following officers were elected for the coming year:

President—Professor E. S. Crawley, University of Pennsylvania.

Vice-President—Dr. John S. French, Jacob Tome Institute, Port Deposit, Md.

Secretary and Treasurer—Dr. J. T. Rorer, Central High School, Philadelphia, Pa.

Members of the Council—Professor W. H. Metzler, Syracuse University; Miss L. G. Simons, New York City Normal College; Dr. J. L. Patterson, Chestnut Hill Academy, Philadelphia, Pa.; Professor W. H. Maltbie, Woman's College of Baltimore.

At the meeting the following resolution was adopted:

Resolved: That this association approve of the organization of a national federation of existing associations of teachers of mathematics in which each association shall preserve its own organization and individuality and which shall have among its objects the joint support of publication. In the federation should be included only societies representing territory as extensive at least as one state.

DISCUSSION AND CORRESPONDENCE.

THE RELATIONS OF MUSEUMS TO EXPERTS AND SYSTEMATISTS WHO ARE ENGAGED IN WORKING UP AND NAMING COLLECTIONS.

From time to time the writer has met those who have maintained the view that a scientific expert is entitled out of collections, whether submitted to him by individuals or by museums, to retain for his own use whatever portion of such collections he may desire to reserve for himself, after having described them. Some years ago a rather well-known entomologist in correspondence laid down the proposition that 'it is the unwritten but universal law that an expert to whom scientific material is submitted for study is entitled to retain therefrom anything he pleases,' and further added the statement that 'it is the indefeasible right of an expert to retain for his own use anything which he may wish to reserve out of the collections submitted to him for study.' These statements being wholly contrary to the teachings of his own experience and observation, the writer was moved to address a circular letter of inquiry to a large number of the most eminent scientific men charged with the administration of the affairs of museums in America and in Europe, inquiring whether they knew of the existence of any such 'unwritten law' or recognized any such 'indefeasible right' on the part of experts to whom they might entrust material for study. The persons to whom this circular letter was addressed are men who stand in the very foremost ranks of science, among them the heads of the greatest museums in Europe and America, and a score of the most eminent investigators along biological lines now living.

The writer received not merely a series of replies upon the blanks provided in the circular letter for answers, but in a number of cases lengthy and interesting letters, which showed that some of the gentlemen addressed had encountered those who held this view, which they reprobated as strongly as does the writer himself. Others expressed unmitigated astonishment that any one should have the temerity to propound such propositions, declaring them to be altogether unheard of and monstrous. Answers were received from forty-four gentlemen in America, who are recognized as the highest authorities in their respective lines of research. Only three of these appeared to claim that usage demands that the expert should be allowed to retain for his own use what he may desire. Two of these were entomologists; one was a botanist. The others most unqualifiedly denied the truth of the propositions and treated them as ridiculous. Twenty replies were received from the

most eminent scientific men of Great Britain. Only one of the number declared the view of my correspondent to be in his judgment correct. The other nineteen utterly reprobated his propositions, declaring them to be in their judgment wholly untenable. Sixteen of the leading scientific men on the continent of Europe replied, all of them rejecting the propositions as unheard of, and contrary to all experience and usage.

It appears from the eighty replies received by the writer that only four, or five per cent., of those whom he addressed, three of these being Americans, had ever heard of the propositions laid down by his correspondent, and the rest all reprobated the doctrine.

What then is the attitude which should be taken by a museum toward the expert who is requested to work up scientific material in the custody of an institution? That he has the right to endeavor to enrich his own collections, if he happens to be a collector, at the expense of the collections submitted to him for study, I think will be almost universally disallowed. That he should, however, be recompensed for his labors, if he desires to be recompensed in any other way than by the pleasure and honor he may derive from being permitted to write upon the material entrusted to him, will be conceded. In case an expert desires a financial return for his service in the way of a *honorarium*, to grant this in accordance with the ability of the institution seems to the writer to be eminently proper. Furthermore, if he desires to retain for his own use and for aid in future study *duplicate material* where such duplicate material exists, it is the opinion of the writer that he should be allowed to do so, and in fact it may be said that it is the almost universal custom to allow experts to retain a reasonable amount of duplicate specimens from collections where such duplicates exist. But *all types of species and genera* based upon collections which are submitted to experts *should be invariably returned* to the owner of the collection, unless a previous arrangement to the contrary has been made. And this is particularly true in the case of the collections of great museums, which are founded for the purpose of recording and preserving for future generations the results of scientific research. The writer has had considerable experience in this matter and has never felt himself at liberty, when called upon to study and examine collections other than his own, to do more than to suggest to those who have had the kindness to submit them to him for examination that he would be pleased in case duplicates existed in the collection to be allowed to retain of this duplicate material sufficient to enable him in coming time to work to greater advantage.

The museums of the country should be cautioned against dealing with any individual who holds the view to which the writer has called attention, and as the head of one of the greater museums of America the writer desires to say that the authorities of this institution will never consent to allow any portions of the collections in their custody to pass out of their keeping into the hands of those who may wish to study them without having, preliminary to such act, reached a clear and distinct understanding to the effect that all types shall be returned to the museum, and that only duplicate material shall be allowed to remain in the possession of the expert, the amount of such duplicate material which is to be granted to be determined by the authorities of the museum themselves. This is in the judgment of the writer correct usage. He knows, however, that there are a dozen or more men of more or less reputation in scientific circles who hold the opposite view. He believes, however, that they are in a hopeless minority, and that their opinion in the matter is unsound from the standpoint both of science and of good morals.

W. J. HOLLAND.

CARNEGIE MUSEUM,
PITTSBURG, PA.

A LECTURE EXPERIMENT IN HYDRAULICS.

TO THE EDITOR OF SCIENCE: The phenomenon of the diminution of pressure in a contracted portion of a water pipe, as exemplified by the so-called jet pump and by the Venturi water meter, always seems paradoxical to the student in physics, and it is important, there-

fore, to bring out the phenomenon in such a way as to divest it of its paradoxical features. Perhaps the most insinuatingly paradoxical aspect of the phenomenon is that which is

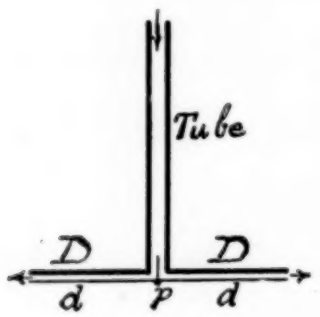


Fig. 1.

presented by the well-known toy which consists of a flat metal disk *DD*, Fig. 1, at the end of a metal tube and a light metal disk *dd*, which is hindered from moving sidewise by a pin *p* which projects into the tube. Blowing through the tube causes the disk *dd* to be held tightly against the disk *DD*.

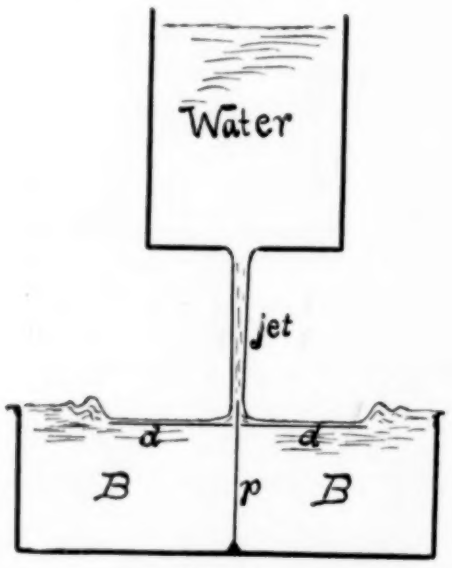


Fig. 2.

Fig. 2 shows an arrangement in which all of the essential actions which enter into the behavior of Fig. 1 are reproduced in a more easily intelligible form. A light metal disk *dd* is prevented from moving sidewise by a pin *p*, and a jet of water impinging upon the center of the disk *dd* causes it to float. The thin stream of water which moves radially outwards over the surface of the disk maintains a wall of water around the edge of the disk, and the disk floats very much as if it were a shallow pan with a metal rim. Over the surface of the disk the thin stream of water has a high velocity and a low level (pressure) and at the edge it raises itself to a higher level (pressure) as it loses its velocity. So, in the case of the apparatus shown in Fig. 1, the thin stream of air between the two disks has a high velocity and a low pressure and at the edge of the disks it raises itself to a higher pressure (atmospheric pressure) as it loses its velocity. Evidently, then, the air between the disks *dd* and *DD* of Fig. 1 is at a lower pressure than the outside air and the difference in pressure operates to hold the disks together.

W. S. Franklin.

THE FIRST DISCOVERY OF FOSSIL SEALS IN AMERICA.

To the Editor of Science: While engaged in collecting fossils for the National Museum from the northern range of the Calvert Cliffs, on the west shore of Chesapeake Bay, Maryland, during the summer and fall of 1905, I had the good fortune to find bones of true seals, which are, so far as I am aware, the first authentic remains of American fossil seals. As the Calvert Cliffs are entirely Miocene at their northern end, these bones can safely be assigned to that geological period. They will be described later in the *Proceedings* of the National Museum.

Remains from several localities in the United States, supposed to be those of seals, have been described or alluded to by Leidy and other writers, but, as shown by Dr. Allen's careful review, they are all of doubtful authenticity, 'not a single extinct species having been certainly determined.'

F. W. True.

U. S. National Museum,
Washington, D. C.,
November 23, 1905.

A BLAZING BEACH.

In the early part of September the papers throughout the country gave wide publicity to the occurrence of a phenomenon at Kittery Point, Me., which attracted much local consideration because of its sensational aspects, and which might be correctly described as a

'blazing beach.' On the evening of Friday, September 1, the guests at the Hotel Parkfield were startled by the appearance of flames rising from the beach and from the surface of the water, an event of so remarkable and unusual a character as to excite great curiosity and some alarm. The conflagration occurred between seven and eight o'clock in the evening, and lasted for upwards of forty-five minutes. The flames were about one foot in height. They were accompanied by a loud and continuous crackling noise which could be distinctly heard one hundred yards away, while at the same time there was a very strong liberation of sulphurous acid fumes which penetrated the hotel, drove the proprietor and his staff from the office and filled the other rooms to such an extent as to cause great inconvenience to the guests. One guest of an investigating turn of mind secured some of the sand in his hand, but was obliged to drop it on account of the heat. When some of the sand was taken into the hotel and stirred in water, bubbles of gas were liberated and produced flame as they broke at the surface in contact with the air.

Some of the attempts at explanation were of a remarkable character and illustrate how far one may be carried when the imagination is not controlled by an adequate knowledge of facts. One observer stated that some vessel in the harbor had thrown overboard a quantity of calcium carbide which had washed ashore and caught fire. The most popular explanations referred the phenomenon to the effects of the blast at Henderson's Point, some six weeks before, the theory being that the explosion of fifty tons of dynamite had opened up rock fissures to such an extent as to liberate volcanic gases; while a somewhat similar theory attributed it to the earthquake of the day before, and the consequent opening up of rock fissures. With respect to the latter it may suffice to state that the earthquake may have been a contributary factor in so far as it served to give just that shaking at a critical moment which would suffice to liberate gases stored under slight pressure. The most sensational explanation was that of a resident of the town who refused to accept the explanation I offered as altogether too commonplace, and who had 'always told the people of Kittery Point that the town was built on the edge of hell, the proof of which had now been given.'

Divesting the phenomenon of its sensational aspects, it was not difficult to reach a satisfactory explanation of all the features presented, and to eliminate explanations which had some semblance of reasonableness. The beach at the point where the fire occurred is composed of a beach ridge at its upper margin, made up of pebbles of varying size. From this ridge, a somewhat sharp slope continues the same formation outward and downward for perhaps seventy-five feet, where the pebbles are replaced by sand. This latter begins at about the half-tide mark and extends outward with a very gentle slope beyond low-water mark, so that during even the lowest tides a portion is covered by very shallow water. This sand beach extends laterally for a distance of about 175 to 200 feet, being limited in each direction by solid ledge, which forms the general construction of the shore all along the river. Over the outer portion of the sand, as also for great distances beyond, wherever there is a muddy bottom, there is an abundant growth of eel grass (*Zostera marina*) which, together with other debris of a similar nature, is continually washed upon the beach, broken up by the action of the waves and gradually buried, so that each year the deposit is increased by definite though rather slight increments. One of the well-defined features of the fire was, that it was limited to that area which is occupied by the sand. It occurred over that portion of the sand which was exposed by the falling tide, but it was also observed to extend out over the water for a distance of thirty or forty feet. Gas was found to be liberated from the exposed sand when stirred in water, and similarly gas was seen to rise from that portion of the sand covered with water. Such facts showed conclusively that the evolution of the gas was immediately connected with the sand itself and not with the adjacent rock formation, hence the theory

that rock fissures had been opened could not be regarded as resting upon a valid basis.

Observation has shown that in the salt marsh lands of the coast the underlying portions of the sod are continually undergoing decay with the formation of large quantities of sulphuretted hydrogen, with which there must also be associated certain amounts of the light carburetted and possibly also of the phosphuretted hydrogen. Personal experience has shown that such gases are stored in the decaying turf in large quantities, being often held in pockets, so that when the turf is cut they may escape in such volume as to drive one away for the time. It is also known that any decaying vegetation will produce similar results, and two explanations were, therefore, suggested as offering a solution of the problem: (1) that there was an area of buried marsh such as is known to exist in places along the coast, and that its decay had given rise to combustible gases; (2) that the accumulations of organic debris in the formation of the beach had been productive of the results observed.

That one or both of these causes would offer an adequate explanation was adopted as a tentative hypothesis, and an examination of the beach was proceeded with. It was found that the superficial layer to a depth of about one inch, consisted of freshly washed sand with which there were mingled fragments of marine plants and even fragments of land plants. Successive accumulations are thus transferred from the superficial layer to that below, which was found to be about six inches in thickness, and to consist of sand filled with all sorts of organic debris, including marine plants, fragments of wood and bones. Moreover, this layer was perfectly black, and when washed it exhibited very small, carbonized fragments of zostera and other marine plants, fragments of wood with a distinct surface charring, and bones of animals, the surface of which was like ebony. Below this layer there was a deposit of beach pebbles mingled with sand, and as this formation continued to the limits which it was possible to reach with the implements at hand—about two feet—the conclusion was reached that such was the lower construction of the beach and that no buried marsh was present. This naturally led to the final conclusion that the six-inch layer, rich in organic matter, was entirely responsible for the production of inflammable gases which had been accumulated there until favorable conditions for their release were presented.

An explanation of the spontaneous combustion of these gases is not difficult. The light carburetted and the phosphuretted hydrogen are well known to ignite spontaneously wherever produced in marsh lands, thus giving rise to the well-known 'will-o'-the-wisp,' 'Jack-o'-lantern' and the ignis fatuus, 'corpse candle,' etc., which are well known to the folk-lore of England. That sulphuretted hydrogen was also present has been abundantly shown, and since this would naturally be set on fire by the other gases, it is possible to reach a complete explanation of a phenomenon which must have occurred at more or less frequent intervals in the past, though escaping observation through lack of combination in those circumstances which would bring it under direct notice. It would seem, however, that the possibility of such combustion on a rather large scale offers a most reasonable explanation of many forest fires, the origin of which it has hitherto been impossible to account for in a satisfactory manner.

D. P. Penhallow.

Botanical Laboratory,
McGill University,
November 17, 1905.

'THE COLLAPSE OF EVOLUTION.'

To the Editor of Science: One of your correspondents, two months or so ago, sent you an outline of an argument against the doctrine of evolution delivered as an address by Rev. L. T. Townsend, professor emeritus in the theological department of Boston University. The paper may now be had as a separate.[1] This pamphlet contains so much in the way of new and surprising information, that it is

[1] Bible League, Credo Series, No. 2, National Magazine Co., Boston and American Bible League, 82 Bible House, N. Y.

clearly 'one of the books which no [scientific] gentleman's library should be without.'

The theory of evolution being now, as Professor Townsend informs us, 'discredited and abandoned by the best scholarship of the world,' it is high time that the 'American university professors' who still continue to deceive the people on this important question, should be called to account. "Were these professors clergymen, would it be discourteous to characterize such an exhibition as a piece of superb ignorance or insolence?" 'We are a little behind the times on these questions in this country as compared with England, France and Germany, though ahead in almost everything else'; and 'the most thorough scholars, the world's ablest philosophers and scientists, with few exceptions, are not supporters, but assailants of evolution,' so that American men of science will do well to heed this clarion call from Boston University. "If these facts as to the attitude of leading scientists, and if this revolution of opinion in Germany are known, and certainly they ought to be, then can the silence of our American evolutionists be looked upon as honest or manly?"

The trouble with us over here in the wilds of North America is that we have been making fine-spun distinction where there is no real unlikeness. "What essential or fundamental difference is there between Darwinism and any scheme of evolution that may be or can be proposed?" Professor Townsend repudiates with scorn the suggestion that he confuses evolution and Darwinism. They are the same thing; and every naturalist who questions the all-sufficiency of selection becomes *ipso facto* an advocate of special creation. De Vries, among others, has his name called right out in meeting on the strength of that eminent scientific authority, the *Literary Digest*.

A muddle-headed chap the evolutionist—or the Darwinian—is at best: see how he gets fooled by the Tertiary horse: "While there is some resemblance between these four-toed animals and the modern horse, as there are some resemblances between a cow and a crow, a man and a mouse, each having a head with its eyes, nose and ears, and each having feet with which to walk, yet these resemblances furnish no more evidence of organic connections and transmutations in the one case than in the other—that is no evidence at all." But then what is to be expected of persons who employ "such terms as 'bathiosm,' 'cosmic ether,' 'cosmic emotion,' 'germplasm,' 'pangenesis,' 'protoplasm,' 'growth force,' 'vital fluid' and the like. * * * It should be said, however, that not for five or ten years have these terms, once potent on the lips of scientists and philosophers, been employed seriously by any reputable writer on these subjects."

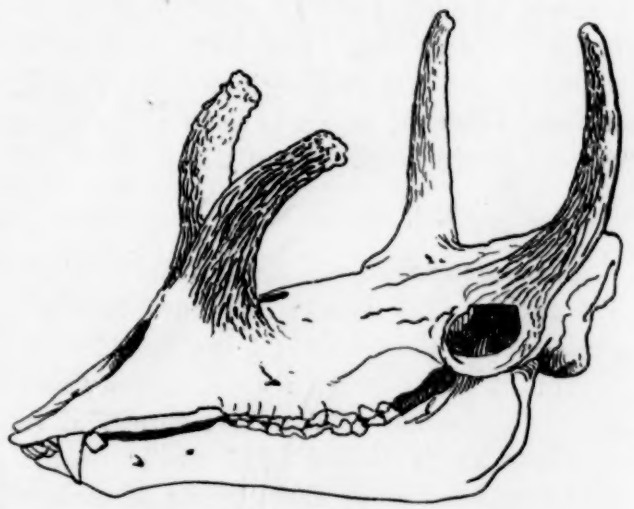
After this warning, if any reader of SCIENCE is caught saying 'protoplasm,' it will be his own fault!

E. T. BREWSTER.

SPECIAL ARTICLES.

A NEW MIOCENE ARTIODACTYL.

AMONG several discoveries made in the Daimonelix beds (Loup Fork) of Sioux County, Nebraska, the most striking one of the season seems to be that of a new four-horned ancestral antelope, *Syndyoceras cooki*, the skull of which is herein figured and briefly described. The discovery was made by Mr. Harold G. Cook, a former Lincoln student and a member of the Morrill geological expedition of 1905.



Syndyoceras cooki, Barbour, 1905.

The specimen, which gives promise of being complete, was found on the west bank of the Niobrara River in the bluffs bordering the extensive ranch of Mr. James Cook, Agate,

Nebr. The skeletal parts known at present are the skull and mandible; the vertebral series, complete as far as exposed, and articulated; the pelvis and sacrum and the hind limbs complete and likewise articulated; several ribs attached to the vertebræ above and to the sternum below, and a portion of one scapula. The fore limbs are not yet in evidence, but will doubtless be found either in the material collected or else in the quarry, which still showed numerous bones when work was suspended.

The most striking characteristic of the skull is the four prominent horns, of which the frontal pair rises upward and curves inward, while the maxillary pair curves in the opposite direction. The maxillary horns, uniting as they do at the base to form a common trunk, divide the anterior nares into two portions, the posterior of which may or may not have been functional. However this may have been, the margin of the opening seems to have been roughened as though for ligamentous attachment. The dentition is complete, though, consequent to age, the teeth are worn. The premaxillæ are edentulous. The upper canines, which are strong and defensive, curve noticeably outward. The lower canines have migrated and assumed an incisiform function, while the first premolars have in a like manner become caniniform. Dentition:

$$\text{I. } \tfrac{0}{3},\ \text{C. } \tfrac{1}{1},\ \text{P. } \tfrac{3}{4},\ \text{M. } \tfrac{3}{3}.$$

Measurements of the skull: Length of skull, $12\frac{3}{4}$ inches (325 mm.); distance between the orbits across the frontals, 5 inches (128 mm.); height of anterior horn cores above plane of molars $6\frac{1}{2}$ inches (166 mm.); spread of same at summits $8\frac{1}{4}$ inches (210 mm.); height of posterior horn cores above plane of molars $7\frac{3}{4}$ inches (197 mm.); spread of same at widest point 10 inches (254 mm.); width of palate between molars $1\frac{1}{4}$ inches (32 mm.).

No attempt should be made at this juncture to fully define the genus. As to its affinities, *Syndyoceras* seems to be remotely related on the one hand to *Protoceras* of the Oligocene, and on the other hand to the modern antelopes. *Syndyoceras* may be placed for the present with the Protoceratidæ, but it is doubtless entitled to a place in a new family.

Erwin Hinckley Barbour.
The University of Nebraska, Lincoln,
October 1, 1905.

Note on the Functions of the Fins of Fishes.

The exact determination of the function of each kind of fin in fishes does not appear to have been treated in a practical manner up to the present time, and these organs are in general regarded as of little importance for swimming. It occurred to me that a few experiments might elucidate the question. Unfortunately, I had and can have, at my disposal, only fishes with fins but little developed and in small number, so that the facts which I am going to set forth have only a relative bearing, and only naturalists having sufficient material at their disposal will be able to establish general rules.

I had in the aquarium of the state college three or four small specimens of *Goodea atripennis* (a cyprinodont) four or five centimeters long, taken in a pond in the state of Guanajuato. One of these individuals attracted my attention by the entire absence of its dorsal fin; whether it had disappeared by accident or whether it had never existed was not evident. Since the creature swam exactly like those which were perfect, I thought of investigating the function of this fin and also of the others, both paired and single.

No. 1. Individual without dorsal fin. My preparator cut off the anal fin close to the body. No difference whatever was observed in the creature's movements. I conclude that, in *Goodea* at least, this organ exerts no influence in swimming or on the equilibrium.

No. 2. I took another fish and had the pectorals and the ventrals amputated, that is to say, the four members. At first the creature appeared somewhat astonished and hesitating; but at the end of an hour it finished by moving deliberately and swimming as usual. The pairs of fins appear, therefore, to have very little if any bearing on locomotion.

No. 3. A third *Goodea* served for the study of the caudal fin. That alone was cut off.

The fish remained at the bottom of the aquarium and went slowly to take refuge under a tile which served as a shelter. It was then three o'clock in the afternoon. The next day at the same hour I found it in a package of *Jussieua* plants which was floating on the surface of the water.

In order to examine my fishes closely, I removed the plants and observed that Nos. 1 and 2 did not appear to be at all influenced by the operation which they had undergone. Only No. 2, deprived of its pectoral and ventral fins, seemed unable to move easily. No. 3 moved the posterior portion of its body quickly, and by uninterrupted lateral shakes was able to turn, rise, fall and swim forward, but with much less rapidity and ease than the others, which, with a stroke of the tail, darted like arrows without needing to strike the liquid again in order to advance. The third fish ended by learning to replace his caudal by the movements of the dorsal and anal, which increased a little in size, doubtless from the exercise.

One more experiment remained to determine the functions of the fins and of the air-bladder. All the fins except the caudal were cut off of one fish. The creature thus mutilated at first appeared undecided, like No. 3, and moved slowly at the bottom of the aquarium; but the next day I saw him swim rapidly and execute with agility all his usual evolutions. The only noticeable peculiarity was that in order to keep himself in position he caused his only fin to vibrate rapidly and constantly, and that these vibrations communicated a trembling to the entire body. The equilibrium was, therefore, still preserved, and the air-bladder did not cause the fish to turn belly upwards, although he maintained himself at the bottom of the water, in the middle or at the surface, experiencing in consequence a series of different pressures. My friend, the learned Belgian professor, F. Plateau, so well known by his experiments on insects, and who encouraged me to publish these studies, writes to me that he teaches his pupils that locomotion in most fishes is effected by flexions of the entire caudal portion of the body, and that the undulations of the odd fins (dorsal, anal and caudal) serve only to give more precision to the general movements of locomotion; and that, save in exceptional cases, the functions of the pairs of fins are almost inappreciable. I am happy to see my observations accord with the ideas of a savant whose name carries weight.

When my fishes swim slowly or remain motionless, the caudal fin executes very clean helicoid movements (skulling). This fin appears, therefore, to be, not indispensable, but extremely useful in swimming. Progression forward is due to the alternate flexions of the tail, that is to say, of the part of the body situated behind the anus, as everybody knows; but, according to the observation made on No. 3, it is evident that the fin which terminates it lends it a very powerful aid, for both rapidity and uniformity of motion. With regard to the function of the pectorals, I have remarked that when the fishes which possessed them remained stationary they, nevertheless, continued to move these fins rapidly, and that the latter appeared to be intended to produce currents in the water to renew the portions of this fluid which had already yielded their oxygen to the gills and remained charged with carbonic anhydride.

It is evident that these experiments on a single species and on so small a number of fishes are insufficient to determine in a general manner the rôle of each kind of fin, and I publish them only to instigate other more varied studies, particularly by means of fishes provided with well-developed fins. With regard to those vertebrates which possess only the caudal, it is known that the shape of their body, especially of the posterior portion, perfectly explains direct progression.

Before closing this article, I wish to call attention to a fact which perhaps has not yet been observed, or at least not published. The amputated dorsal fin and the two pectoral fins have grown out again to a great extent. It is probable that the mutilated fishes continued mechanically to make use of the stump which remained to them, doubtless with a small fragment of the fin, and that under that action the

rest of the organ reproduced itself. What would seem to prove it is the fact that, as I have said in speaking of No. 3, the dorsal fin increased in size on account of the use he made of it to replace the amputated caudal fin.

A. Dugès.

Guanajuato, Mexico,
April, 1905.

LABORATORY EXPERIMENTS WITH CS_2 TO DETERMINE THE LEAST AMOUNT OF GAS AND THE LEAST TIME REQUIRED TO KILL CERTAIN INSECT REPRESENTATIVES OF VARIOUS FAMILIES.[1]

While a sufficiently large series of insects has not yet been worked upon to draw a definite conclusion upon the above point, the following paper is submitted as showing some interesting results incident to this work. Experiments were begun in California a few years ago, and continued for a time in Minnesota. Three hundred and eighty-six insects have been tested. Of this number some have not been included in the tables, where the record was not regarded as sufficiently complete.

The points which might be brought out by an exhaustive series of observations in this line are as follows: Least strength required with a minimum expenditure of time to kill (*a*) insects in general, (*b*) particular groups, safety to foliage being understood; effect of moisture upon results; effect of temperature upon results; expense of material for effective use upon a known number of plants, trees, insect colonies or stored products, what per cent., if any, succumbed after seeming recovery; beginning effects of gas upon (*a*) insects in general, (*b*) groups in particular; significance of occasional spasmodic movements of legs, wings, sometimes long after apparent death; corroboration of laboratory results with results from the field as far as possible; different results with different brands of CS_2; corroboration with previous published statements.

Method and Apparatus Described; Computation.—The necessary crudity of the apparatus and method described is evident, and must render the results in the case of insects of any size not even approximate. An insect as large as *Ectobia,* or *Apis mellifica,* for example, or the larva of the western peach-tree borer, or that of the Mediterranean flour moth, evidently displaces so much of the gaseous contents of a vial when introduced, as to render absurd the proportions of gas to atmosphere as given. Even in insects smaller than these there is undoubtedly an error due to displacement, yet the writer believes that the method described here comes as near demonstrating facts in this connection as possible, particularly in the case of very small insects, and it has certainly brought out interesting results, from which we may select what appears authentic.

A large number of homeopathic vials were secured, of the same size (homeopathic 2 gram vial No. 1,657 with patent lip), also pieces of flexible rubber piping of such a size as to fit tightly over these vials. Into one vial a drop of CS_2 was allowed to fall from a medicine dropper, and the mouth of this vial immediately placed against the mouth of another empty vial, the rubber tubing referred to serving to hold the two vials closely together, and preventing any egress of gas, or entrance or exit of atmosphere.

The average capacity of these vials was 8.7 c.c., and it was upon this basis that our calculations were made. The volume of gas coming from one drop of CS_2 equaled 4.35 c.c., and, therefore, filled half a vial.

It is evident, therefore, that the union of the first two bottles, made immediately, before the gas had an opportunity of driving out any of the atmosphere, caused a mixture of one part of gas to four of atmosphere; the second change, one to eight; the third, one to sixteen; the fourth, one to thirty-two, etc., or, interpreting it with reference to the liquid volume of CS_2 to the atmosphere, we find that the union of the first two bottles equaled one part of liquid CS_2 to 1,494 parts of atmosphere, or in round numbers, 1,500 parts of atmosphere; the second change, one part of liquid CS_2 to 2,988 parts of atmosphere, or in round num-

[1] Abstract of paper read before the Association of Economic Entomologists at Philadelphia at their last annual meeting.

bers 3,000 parts of atmosphere; the third change, one part of liquid CS_2 to 6,000 parts of atmosphere; the fourth change, one part of liquid CS_2 to 12,000 parts of atmosphere, and so on.

The greatest pains were taken to secure volatilization of the liquid. Nearly half an hour was allowed to elapse after the drop was enclosed before changing bottles, and no change was made as long as the slightest evidence of the liquid CS_2 was observed.

confusum) were treated, of which fifty-eight were entered in tables as offering authentic results. Experiments with fifty-two diptera were tabulated, as were also experiments with fifty-six hemiptera (mostly aphids). Forty lepidopteran larvæ were used and results tabled, and thirty-one hymenoptera. A few entries in the tables are here given as an example of the method employed, and at the same time offering an illustration of the somewhat remarkable vitality of the Aphidæ.

No.	Name.	Strength.	Exposure. hr. m.	Died.	Recovered.
31	Aphid.	1-24,000	27		9 minutes—died later.
32	"	1-24,000	25		41 "
33	"	1-24,000	20	Yes.	
94	"	1-12,000	2 4	"	
123	Mealy Bug.	1-12,000	50		2 hours 20 minutes.
124	" "	1-12,000	54	"	
125	" "	1-24,000	1 8	"	
126	" "	1-24,000	1 12		Next A.M.
127	" "	1-24,000	28	"	
128	" "	1-48,000	1 20	"	
129	" "	1-48,000	2 38	"	
130	" "	1-48,000	1 7		
131	" "	1-24,000	15	"	
132	Aphid ad. wgl.	1-24,000	14		4 hours 25 minutes.
133	" juv.	1-24,000	14		4 " 25 "
134	" "	1-24,000	13		4 " 25 "
135	" "	1-24,000	13		4 " 25 "
136	" "	1-24,000	12		4 " 25 "
137	" "	1-24,000	12		4 " 25 "
138	" "	1-24,000	11		4 " 25 "
139	" "	1-24,000	11		4 " 25 "
140	" ad. wgl.	1-48,000	1 42		1 hour 18 "
141	" "	1-48,000	44		1 " 7 "
142	" juv.	1-48,000	1 42	"	
143	" "	1-48,000	1 38	"	
144	" "	1-48,000	1 41		1 " 7 "
145	" "	1-48,000	1 40		2 hours
146	" "	1-24,000	1 8	"	
147	" "	1-24,000	1 8		Next A.M.
148	" "	1-24.000	2 21	"	
149	" "	1-24,000	2 30	"	
150	" "	1-24,000	2 22	"	
151	" "	1-48,000	2 12	"	
152	" "	1-48,000	2 08	"	

Now then, it is evident that if our calculations are correct, we could by placing it in an empty vial, and then applying it as above described to one of the vials containing a mixture of gas and atmosphere, expose an insect to any desired proportion of gas and atmosphere.

One hundred and fifty-six specimens of coleoptera (largely composed of *Tribolium*

Conclusions.—The experiments demonstrate that it is very much easier to kill diptera than coleoptera. It is further to be noted that insects are apparently dead long before death actually occurs. I have no doubt but that there is an immediate effect upon the individual insect coming in contact with the gas, although it does not always show this. By 'effect' as noted in the tables, we mean the

first marked uneasiness on the part of the insect under treatment. In some cases this effect is immediate.

It is to be also noted in this particular that in the case of many specimens the first noticeable effect was an attempt on the part of the insect to clean its antennæ. The striking individual variations, in other words, the revival of many subjects after apparent death, show the necessity of extreme thoroughness in field and greenhouse, that is, a long enough exposure to insure carrying the insect beyond all possibility of recovery.

One hour's exposure to one part liquid CS_2 to 12,000 parts of atmosphere is apparently sufficient to kill aphids, but in making suggestions for practical application, I should certainly urge an hour and a half's exposure to that strength as being more sure, especially with crude CS_2. Ants appear generally to succumb to one hour's exposure to one part liquid CS_2 to 12,000 parts of atmosphere, the same as aphids, and yet in actual practise, to insure the best results, they should be subjected to a longer treatment. Aphids show immediately the effect of exposure, and some were on their backs from two to four minutes after treatment, and yet recovered after an exposure of three fourths of an hour to one part liquid CS_2 to 12,000 parts of atmosphere. *Tribolium confusum* was observed particularly to clean the antennæ immediately upon exposure.

The remarkable vitality of the Aphidæ (insects that we commonly regard as extremely delicate) is to be noted in connection with this work. Further, in a few cases we found that some of the insects which recovered such treatment died later, say within twenty-four hours, although the bottles in which they were confined were left open, only slightly plugged with absorbent cotton. This 'apparent death' is very deceiving. To all appearances these insects were absolutely dead, perfectly motionless, and in many cases we entered them on the record as dead, although we had to change that record several minutes later, when a wing, a leg or an antenna would be seen to move. Frequently only a slight movement of the mouth parts, all other appendages being quiescent, would indicate that the insect treated was still alive.

F. L. Washburn.
Minnesota Experiment Station,
St. Anthony, Minn.

A NOTE ON THE CALCULATION OF CERTAIN PROBABLE ERRORS.

The purpose of this note is to call the attention of workers in biometry to a point which serves to lessen somewhat the labor of computation in the frequently arising cases when one wishes to test whether a given frequency distribution obeys the normal law. Though sufficiently obvious, the point seems not to have been noticed.

In determining whether a given distribution of frequency follows the normal or Gaussian law it has been shown by Pearson[1] that the important constants are

$$\sqrt{\beta_1} = \sqrt{\frac{\mu_3^2}{\mu_2^3}},$$

$$3 - \beta_2 = 3 - \frac{\mu_4}{\mu_2^2},$$

$$\text{the skewness} = \tfrac{1}{2}\,\frac{\sqrt{\beta_1}(\beta_2 + 3)}{5\beta_2 - 6\beta_1 - 9},$$

and the 'modal divergence,'

$$d = \text{skewness} \times \sigma.$$

All these constants should equal zero within the limits of the error due to random sampling if the distribution be truly normal.

The probable errors concerned are (for the normal distribution), when $N =$ the total number of individuals,

$$\text{Probable error of skewness} = .67449\sqrt{\frac{3}{2N}}, \quad \text{(i)}$$

$$\text{Probable error of } \sqrt{\beta_1} = .67449\sqrt{\frac{6}{N}}, \quad \text{(ii)}$$

$$\text{Probable error of } \beta_2 = .67449\sqrt{\frac{24}{N}}, \quad \text{(iii)}$$

$$\text{Probable error of } d = .67449\sqrt{\frac{3}{2N}}\cdot\sigma. \quad \text{(iv)}$$

It is at once clear that the values of expressions (i), (ii) and (iii) stand in the relation to each other of

$$1 : 2 : 4.$$

[1] *Biometrika*, Vol. 4, pp. 169–212.

So then in practise it will be necessary to calculate from the formula only one of these probable errors for a given distribution, viz., the probable error of the skewness. Having determined this we need only to multiply it by 2, by 4 and by σ to obtain the values for the other three. RAYMOND PEARL.

BOTANICAL NOTES.

HALLIER'S NATURAL SYSTEM.

IN the July number of *The New Phytologist* Professor Dr. Hans Hallier discusses further his provisional scheme of the phylogenetic system of flowering plants. The general features of his system are: (1) the Angiospermae constitute a monophyletic group; (2) the Amentaceae are not an old type remaining in a lower state of development, but as 'the highest and most reduced types of one of the lines of Dicotyledons'; (3) they and all other lines of Dicotyledons have been developed by reduction of flower and fruit from the *Polycarpicae*, the latter group being derived immediately from *Bennettitaceae* or other extinct Cycadales; (4) in the same manner, the *Liliiflorae* and all other syncarpous Monocotyledons have been derived by union of the carpels, by reduction in the number of parts, by epigynous insertion of the perianth, and by other changes in the structure of flower and fruit from the polycarpous Monocotyledons (*Helobiae*), which latter group originated from the polycarpous Dicotyledons (*Polycarpicae* and *Ranales*); (5) the *Apetalae* and *Sympetalae* are unnatural groups.

In applying these general principles, Dr. Hallier has worked out the following arrangement of the Dicotyledons, which he distinctly says is provisional for all after the Piperales.

1. POLYCARPICAE (*Magnoliaceae, Canellaceae, Anonaceae, Myristaceae, Calycanthaceae, Monimiaceae, Lauraceae*).

2. RANALES (*Berberidaceae, Menispermaceae, Ranunculaceae, Nymphaeaceae, Ceratophyllaceae*).

3. RHOEDALES (*Papaveraceae, Capparidaceae, Resedaceae, Cruciferae*).

4. PIPERALES (*Lactoridaceae, Piperaceae, Chloranthaceae, Myrothamnaceae*).

5. MALVALES (*Sterculiaceae, Papayaceae, Euphorbiaceae, Bombacaceae, Malvaceae, Elaeocarpaceae, Tiliaceae, Rhamnaceae, Urticaceae, Dipterocarpaceae*).

6. EBENALES (*Sapotaceae, Convolvulaceae, Ebenaceae, Symplocaceae, Styracaceae*).

7. GERANIALES (*Zygophyllaceae, Cneoraceae, Oxalidaceae, Geraniaceae, Linaceae*).

8. MYRTIFLORAE (*Lecythidaceae, Caryocaraceae, Rhizophoraceae, Lythraceae, Myrtaceae, Melastomaceae, Combretaceae, Geissolomaceae, Penaeaceae, Oliniaceae, Thymelaeaceae, Elaeagnaceae*).

9. ROSALES (*Saxifragaceae, Rosaceae, Anacardiaceae, * * * * Meliaceae, Rutaceae, * Leguminosae, * * * * * * * Sapindaceae, * Celastraceae, * Aquifoliaceae, * * * * * Guttiferae, * * Dilleniaceae*).

10. ERICALES (*Clethraceae, Pirolaceae, * Ericaceae, * * * Diapensiaceae, * * Primulaceae*).

11. SARRACENIALES (*Sarraceniaceae, Droseraceae*).

12. SANTALALES (*Olacaceae, Ampelidaceae, * Santalaceae, Myzodendraceae, Gnetaceae, Loranthaceae*).

13. UMBELLIFLORAE (*Cornaceae, Araliaceae, Adoxaceae*).

14. AMENTIFLORAE (*Hamamelidaceae, Myricaceae, Salicaceae, Juglandaceae, Betulaceae* (incl. *Casuarineae*), *Fagaceae*).

15. PASSIFLORALES (*Flacourtiaceae, Violaceae, Cistaceae, * * Passifloraceae, * * * Onagraceae, * * * Gentianaceae, Aristolochiaceae, Rafflesiaceae, Loasaceae, Begoniaceae, Cucurbitaceae, Campanulaceae, * * * Compositae*).

16. CENTROSPERMAE (*Crassulaceae, Cactaceae, * * * * Portulacaceae, * Phytolacaceae, Tamaricaceae, Caryophyllaceae, Polygonaceae, * * Amarantaceae, Chenopodiaceae, Batidaceae*).

17. CAPRIFOLIALES (*Caprifoliaceae, Valerianaceae, Dipsaceae*).

18. TUBIFLORAE (*Apocynaceae, Loganiaceae, Rubiaceae, Bignoniaceae, Oleaceae, * * Acanthaceae, Verbenaceae, Labiatae, Scrophulariaceae, * Solanaceae, Polemoniaceae, Boraginaceae, Hydrophyllaceae*).

The arrangement of the Monocotyledons is merely begun, the families of the Helobiae alone being given (*Butomaceae, Alismaceae, Hydrocharitaceae, Potamogetonaceae, Aponogetonaceae, Juncaginaceae, Triurdiaceae*).

We can agree with the author in regard to the general plan of his system, of which he says: "I freely confess that it gives only an approximate idea of lines of descent and of the natural relations of the flowering plants: it is only one step in the further progress of phylogenetic botany. But I am sure that this step is not a wrong and useless one, and that it will lead to a broader knowledge of the flowering plants."

THE AMERICAN FOREST CONGRESS.

Early in the present year (January 2 to 6) the American Forest Congress was in session in Washington, D. C. Its purpose was 'to establish a broader understanding of the forest in its relation to the great industries depending upon it: to advance the conservative use of forest resources for both the present and future need of these industries: to stimulate and unite all efforts to perpetuate the forest as a permanent resource of the nation.' The papers read in this congress have been collected by Mr. H. M. Suter and published in a volume of 475 pages. These have been arranged systematically under the following heads. (1) 'Forestry as a National Question'; (2) 'Importance of the Public Forest Lands to Irrigation'; (3) 'The Lumber Industry and the Forests'; (4) 'Importance of the Public Forest Lands to Grazing'; (5) 'Railroads in Relation to the Forest'; (6) 'Importance of Public Forest Lands to Mining'; (7) 'National and State Forest Policy.' The book possesses much value, not only to foresters, but to botanists as well.

MORE PLANT CELL STUDIES.

The series of articles by Bradley M. Davis entitled 'Studies on the Plant Cell,' which began in the May number (1904) of the *American Naturalist,* has been brought to a close in the October number (1905), and we have now the whole work before us. In looking over its pages, we are more and more impressed with its value and importance to students of plant cytology, since it presents a summary of the results of recent work not attainable elsewhere. It is to be hoped that the author may be able to push to early completion the preparation of a book on cytology planned to follow pretty closely the outlines given in these studies. In the meantime, many botanists will be glad to know that reprints of these papers are obtainable of the author, at the University of Chicago.

The closing section, which covers about forty-five pages, is devoted to the 'Comparative Morphology and Physiology of the Plant Cell.' About a dozen pages are given to the simplest types of cells, as they occur in the blue green algae, the bacteria and the yeasts, and a clear summary is made of the views of the investigators of these low plants. The author is able, from the incomplete and somewhat conflicting testimony, to find some justification of the belief in the presence of nuclear structures, even in the smallest bacteria. Interesting comparisons are made of the structure of simpler plant cells with those of higher types, in which many gaps in our knowledge are pointed out, one of which is the connection of the Schizophyta with the lower green algae. The structure of the trophoplasm, the reproduction of plastids, the individuality of the chromosomes, the functions of the vacuoles, the nature and occurrence of centrosomes, the balance of nuclear and cytoplasmic activities, are among the topics discussed in the closing pages of this interesting section, which, like the preceding sections, is followed by an extensive bibliography.

Charles E. Bessey.
The University of Nebraska.

THE AMERICAN CHEMICAL SOCIETY.

The sessions of the thirty-third general meeting of the American Chemical Society and those of Section C of the American Association for the Advancement of Science will be held in the lecture rooms of Tulane University, New Orleans, from December 29 to January 2.

The preliminary program is as follows:

FRIDAY, DECEMBER 29.

Forenoon.—At the close of the general session of the American Association for the Advancement of Science, Section C will hold a brief session for organization. This will be followed by the opening session of the American Chemical Society in the same room at about 11:45 A.M. Two addresses will be given: 'Some Important Problems in Agricultural Chemistry,' by Harvey W. Wiley; 'Recent Experimental Researches on Osmosis,' by Louis Kahlenberg.

Afternoon, 2:30 P.M.—Address of the retiring chairman of Section C of the American Association for the Advancement of Science, Leonard P. Kinnicutt. Subject: 'The Sanitary Value of a Water Analysis.'

SATURDAY, DECEMBER 30.

Forenoon.—Session of the American Chemical Society at 9:30 A.M. Subject: 'The Construction of a Chemical Laboratory,' by William L. Dudley. This will be followed by meetings of the sections: Physical and Electrochemical, Louis Kahlenberg, chairman; Inorganic, William L. Dudley, chairman; Organic, Charles F. Mabery, chairman; Agricultural and Sanitary, Harvey W. Wiley, chairman; Industrial, Samuel W. Parr, chairman.

If enough papers are offered to warrant it, a biological section will be formed, with William J. Gies as chairman.

Afternoon, 2 P.M.—Excursions to visit industrial establishments. The following excursions have been suggested, but the exact details are not yet arranged: Visits to a sugar refinery, a molasses distillery, a cotton-seed oil mill, cotton compress, plants for the distillation of wood and for the manufacture of vinegar by the rapid process from molasses, fertilizer works and rice mills.

Evening, 8 P. M.—The retiring president of the American Chemical Society, Francis P. Venable, will deliver an address upon the subject of 'Chemical Research in the United States.'

MONDAY, JANUARY 1.

Forenoon, 9:30 A. M.—General meeting of Section C of the American Association for the Advancement of Science, at which Professor Charles F. Mabery will preside. Addresses: 'The Composition of Petroleum from American Fields—Pennsylvania, Ohio, Texas, Kansas, Wyoming, Colorado, Kentucky and California,' by Charles F. Mabery; 'Some Notes on the Service Waters of a Railway System,' by Samuel W. Parr. These addresses will be followed by meetings of the sections.

Afternoon, 2 P.M.—Excursions to visit industrial establishments.

Evening, 7 P.M.—A subscription dinner open to all chemists in attendance on the meeting.

TUESDAY, JANUARY 2.

Forenoon, 9:30 A.M.—Meetings of the sections, or visits to industrial establishments, according to the exigencies of the program.

RAILWAY RATES FOR THE NEW ORLEANS MEETING.

THE railway rates for the New Orleans meeting of the American Association for the Advancement of Science are now all in. As already noted in previous numbers of SCIENCE and in the preliminary announcement, which is now in the hands of all members, a standard rate of one fare plus twenty-five cents for the round trip has been granted by the Southeastern Passenger Association and by the Central Passenger Association. The Southeastern Passenger Association includes the territory south of the Ohio and Potomac Rivers and east of the Mississippi except that in West Virginia the territory is south of Charleston and in Virginia the town of Staunton is in the Trunk Line Association. The Central Passenger Association includes the whole of Michigan, Ohio and Indiana, the northwest corner of Pennsylvania and lower Ontario, in addition to the southern and eastern portion of Illinois. The Trunk Line Association, including New York, New Jersey, Delaware and Maryland, and all of Pennsylvania, except the northwestern corner, West Virginia north of Charleston, and northwestern Virginia, offers one fare and one third to the southern or western termini of Trunk Line railroads, and one fare plus twenty-five cents from those points. The Western Passenger Association, including the northern peninsula of Michigan, Wisconsin, Minnesota, the eastern half of North Dakota, all of South Dakota, Nebraska, Iowa, Kansas, the northern portion of Illinois, the northern portion of Missouri north of St. Louis, and the eastern half of Colorado, offer one fare plus two dollars for the round trip, except that from points from which the local railway rate to the eastern gateways of the Association (Chicago, Peoria and St. Louis)

is six dollars or less through rate is made on the basis of fare and one third for the round trip to such gateways added to rate of one fare plus twenty-five cents for the round trip tendered therefrom, provided that where such one and one-third fare to Chicago is two dollars or less, fifty cents additional be added for return transfer. The Southwestern Excursion Bureau, which includes all of Texas, Missouri south of St. Louis, and a central strip through Illinois up to Chicago, offers one fare plus two dollars. The Trans-Cont nental Passenger Association, which includes the Pacific coast states, offers rate of approximately two cents per mile, or about one fare and a third for the round trip.

The purchasing dates are as follows: Trunk Line Association from Washington, December 26, 27, 28, 29; from other points, December 26, 27, 28. Central Passenger Association, December 26, 27, 28. Southeastern Passenger Association, December 27, 28, 29. Western Association, December 26, 27, 28.

The date of return is arranged so that ticket holders must reach original starting point not later than January 6 in all cases, except under the Trans-Continental Association.

SCIENTIFIC NOTES AND NEWS.

A CABLEGRAM to the daily papers states that the Nobel prize in medicine has been awarded to Professor Robert Koch, of Berlin, the prize in physics to Professor Philipp Lenard, of Kiel, and the prize in chemistry to Professor Adolf von Baeyer, of Munich.

DR. ALBRECHT PENCK, professor of geography in the University of Vienna, has been elected a member of the Vienna Academy of Sciences. Dr. Richard Hertwig, professor of zoology at Munich, has been elected a corresponding member of the same academy.

THE Geological Society of London has elected Professor Louis Dollo, Brussels, and Professor A. Rothpletz, Munich, to be foreign members in the places of Baron F. von Richthofen and Professor Gustave Dewalque, both recently deceased.

DR. WILHELM WUNDT, the eminent psychologist of the University of Leipzig, celebrated the fiftieth anniversary of his doctorate on November 10.

DR. E. EHLERS, professor of zoology at Göttingen, who celebrated his seventieth birthday on November 11, has been elected a corresponding member of the Senckenbergische Naturforschende Gesellschaft at Frankfurt.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Lieutenant-General Sir Richard Strachey, G.C.S.I., F.R.S.

PROFESSOR C. S. SHERRINGTON, F.R.S., and Professor R. Threlfall, F.R.S., have been elected honorary fellows at Gonville and Caius College, Cambridge.

PROFESSOR C. S. SARGENT, of Harvard University, has sailed for Chili and the mountains of South America to obtain specimens for the Arnold Arboretum.

PROFESSOR WILHELM OSTWALD addressed the Washington Academy of Sciences on November 28, on 'The International Language.' The address was discussed by Professor Maurice Bloomfield, of the Johns Hopkins University, and by Professor M. Carroll, of the George Washington University.

PROFESSOR A. V. STUBENROUCH, of the University of California agricultural department, has accepted a position in the division of pomology in the Bureau of Plant Industry of the United States Department of Agriculture.

CAPTAIN ADMUNDSEN, as the daily papers have fully reported, has succeeded in passing through the Northwest Passage, and making observations about the North Magnetic Pole.

SIR CLEMENTS MARKHAM lectured before the Royal Geographical Society on November 13, on 'The Next Great Arctic Discovery,' which he held to be exploration over the continental shelf of Beaufort Sea.

PROFESSOR HERBERT C. SADLER, of the department of marine engineering at the University of Michigan, has returned from a trip in the east, where he attended a meeting of the Society of Naval Architects and Marine Engineers in New York City. During his absence he delivered a lecture before the marine engineering department of the Boston Polytechnic Institute on 'The Present Status

of the Turbine in Marine Work.' Since Dr. Sadler's return the big naval tank in the new engineering building has been filled with water and the long and tedious task of testing has begun. The tank is now being tested for leakage and evaporation and it is thought that the different tests necessary before the tank can be used will occupy nearly the whole year.

THE funeral services of Sir John Scott Burdon-Sanderson, formerly regius professor of medicine, in the University of Oxford, took place at Magdalen College, Oxford, on November 8. Many members of the university and men of science were present.

DR. W. J. MCMURRAY, president of the Tennessee State Board of Health, died at Nashville, on December 4, aged sixty-three years.

MR. J. S. BURCHAM, A.M. (Stanford, 03), was drowned in Alaska on November 12. He was in the employ of the United States Bureau of Fisheries, and was with the U. S. S. *Albatross* as an expert on salmon and other fishes.

THERE will be a civil service examination, on January 3, to fill the position of physical chemist in the Bureau of Weights and Measures, Manila, at a salary of $2,250. The examination consists only of ratings on training, experience and publications. On the same day there will be an examination to fill the position of teacher of agriculture in the Chilocco School, Okla., at a salary of $1,000.

THE trustees of the British Museum have presented the trustees of the Carnegie Museum with a fine series of reproductions of some of the more striking and important paleontological specimens in their collection, and have also made a gift of all their publications to the museum. This act of courtesy is in recognition of the kindness displayed by Mr. Carnegie in placing in the British Museum a facsimile of the skeleton of the great reptile Diplodocus, which was installed at South Kensington last May.

THE fifth meeting of the California Branch of the American Folk-Lore Society was held in Berkeley, on December 7. Professor William Frederic Badè, of the Pacific Theological Seminary, gave a lecture on 'Hebrew Folk-Lore.'

AN organization to be known as the Conference of New England Professors of Education was formed at a meeting held at Harvard University, on December 1. Discussion on 'The aims, scope, means and methods of the work of the department of education in colleges and universities' was led by Professor W. B. Jacobs, of Brown University, and President Hall, of Clark University. Professor P. H. Hanus, of Harvard, was elected president, and W. B. Jacobs, secretary. The next meeting will be held on the Friday following Thanksgiving next year.

THE yacht *Galilee*, engaged in the magnetic survey of the North Pacific Ocean under the auspices of the Department Terrestrial Magnetism of the Carnegie Institution of Washington, arrived at San Diego, on December 9, having completed a successful series of magnetic observations embracing the regions between San Francisco, San Diego, Honolulu, Fanning Island and the magnetic equator.

FOR the best essay on 'Moral Training in Public Schools' a prize of five hundred dollars is offered, and for the second best, three hundred dollars. The conditions are: (1) Length of essay to be not less than 6,000 nor more than 12,000 words; (2) each essay must be submitted typewritten; (3) all essays must be in the hands of the committee not later than June 1, 1906. These prizes are offered by a citizen of California who desires his name withheld. He has appointed Rev. Chas. R. Brown, of Oakland, California; President David Starr Jordan, of Stanford University, and Professor F. B. Dresslar, of the University of California, Berkeley, 'trustees of the fund and sole judges of the merits of the essays submitted.' The two prize essays shall become the property of the trustees, to be by them 'published and circulated as widely as possible' from the fund at their disposal 'within the limits of the United States.' Any essay not awarded a prize will be returned to the writer upon request, accompanied by postage.

THE Mercers' Company has made a grant of £250 to the Middlesex Hospital Cancer Charity; £150 is to be allotted to the Cancer Research Fund, of which £50 is to be awarded

to one of the workers of the cancer research laboratories, and styled 'The Mercers' Prize.'

The Royal Scottish Geographical Society celebrated its twenty-first anniversary at Edinburgh on November 27, with the president, Professor James Geikie, in the chair.

The Wisconsin Archeological Society has now a total membership of 500. They are securing the custodianship, for school purposes, of the last group of mounds remaining in Milwaukee. In the spring there will be held a joint meeting of the Wisconsin Landmarks Committees and of the Wisconsin Archeological Society, under the auspices of the latter. This meeting will be held among the mounds preserved on the campus of Carroll College, Waukosha. They will soon have completed the details of the preservation of the celebrated 'man' mound at Baraboo.

A national society for the preservation of the American bison was organized on December 8 at the office of Mr. William T. Hornaday, director of the New York Zoological Park. President Roosevelt has consented to hold office in the society.

UNIVERSITY AND EDUCATIONAL NEWS.

Through the will of the late Dr. A. F. Elliott, of California, the University of California will receive $200,000 for the erection of a public hospital.

Dr. Albert Goldspohn has given $25,000 for the erection of a science hall at the Northwestern College, Naperville, Ill.

The faculty of the University of Wisconsin at its last meeting discussed the present status of intercollegiate athletics, and decided to appoint a committee of seven of its members to consider the problem of intercollegiate sports as now conducted and to report to the university faculty the results of its deliberations. President Van Hise has appointed the following members to this committee: Dean E. A. Birge, of the College of Letters and Science, Dean F. E. Turneaure, of the College of Engineering, Professors D. C. Jackson, D. C. Munroe, C. S. Slichter, A. Trowbridge and F. J. Turner.

Plans being completed by Professor D. C. Munroe, director of the University of Wisconsin summer session, provide for the appointment of a number of non-resident professors to take the place of those members of the faculty who do not desire to give instruction in the summer session. The appointments already made include Professor Albert Perry Brigham, head of the department of geology of Colgate University, who will give courses in the principles of physiography and the physiography of the United States. He will also conduct excursions to points of geologic and physiographic interest about Madison, including Devil's Lake, the Dells of the Wisconsin River, Blue Mounds, which have been such an important feature of the summer work in geology.

Professor P. H. Rolfs, at present in charge of the subtropical laboratory of the U. S. Department of Agriculture, at Miami, Florida, has been elected director and horticulturist of the Florida Experiment Station. He was connected with that institution for several years previous to entering the service of the Deparment of Agriculture.

Theodore de Leo de Laguna, A.B. (California), Ph.D. (Cornell), has been made assistant professor of education in the University of Michigan, to fill the place left vacant by the resignation of Professor Alger.

Dr. H. R. Moody, of Hobart College, has been appointed assistant professor of chemistry at the College of the City of New York.

The following changes have taken place in the faculty of the Colorado School of Mines this year: W. G. Haldane has been advanced from instructor to assistant professor of metallurgy; W. F. Allison from instructor in surveying to assistant professor of civil engineering; C. E. Smith has been appointed instructor in geology to take the place of J. W. Eggleston, who resigned to accept an instructorship in Harvard University, and A. J. Hoskins, formerly with the Leyden Coal Company, was appointed assistant professor of mining engineering. Under the new administration the laboratory equipment, especially in ore dressing, is rapidly increasing.